Affinity Water

AFW102 Review of Ofwat's smart metering assessment at PR24

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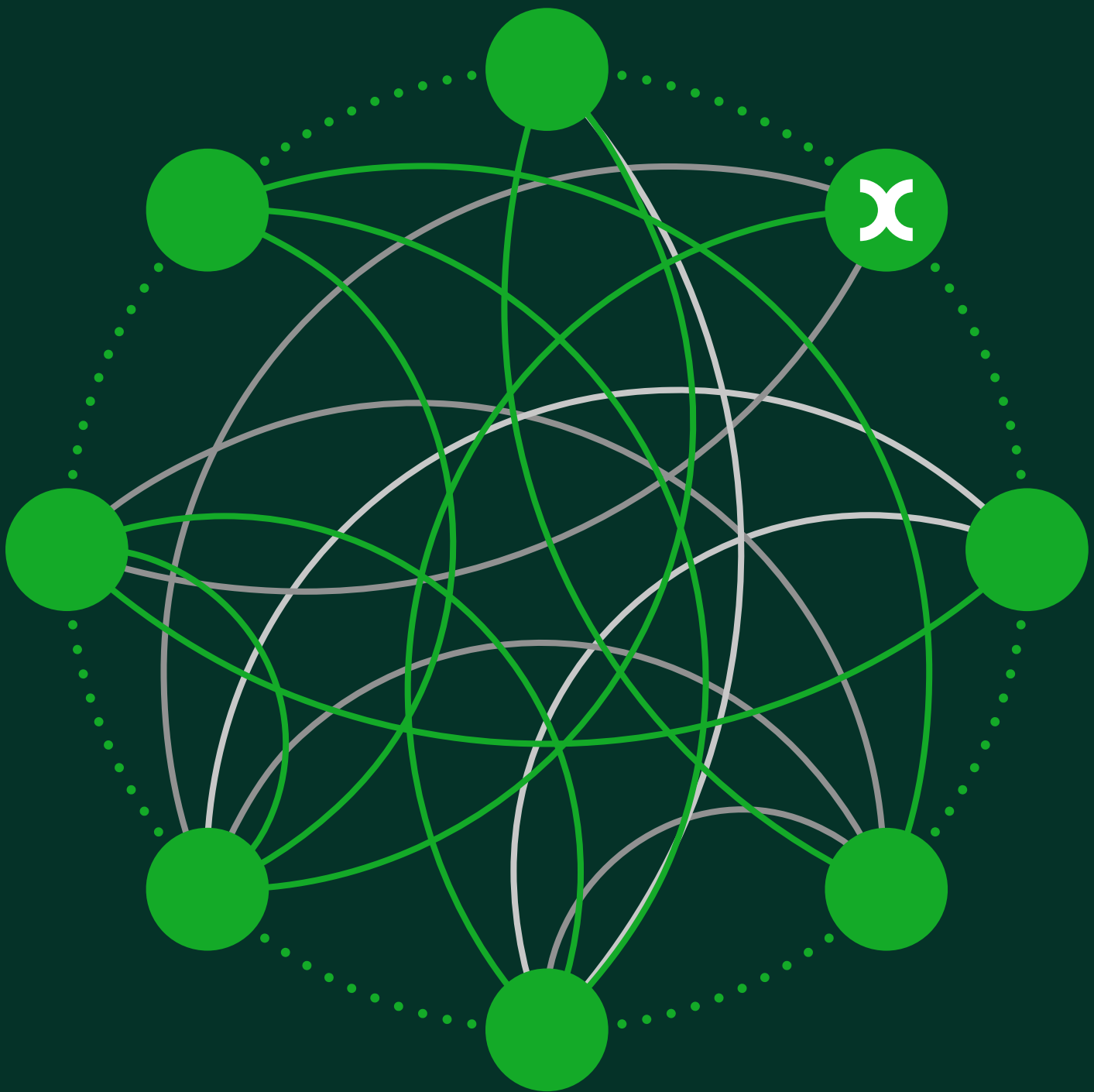

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Introduction

Ofwat asked companies to consider smart meter solutions in their PR24 business plans (BP), on the basis that smart metering can deliver broader customer and societal benefits (such as, leakage and consumption reduction).[1] The scale of companies' smart metering programmes to reduce demand are defined through the water resources management plan (WRMP) process, and Ofwat has sought to fund companies for the number of smart meters identified therein.[2]

At a high level, Ofwat has assessed new smart meter installations and the proposed upgrades of existing meters to smart meters separately. While new installations are funded through enhancement expenditure alone, Ofwat has provided funding for meter upgrades through two sources.

- **Base cost adjustment (BCA)**: the aim of this sector-wide post modelling adjustment is to fund the like-for-like meter replacement element of (all) required meter upgrades, over and above that implicitly funded through Ofwat's base cost models at PR24 and previously at PR19.
- **Meter upgrade enhancement**: the aim of the complementary enhancement modelling is to fund the technology upgrade cost element for (mostly) the same set of meters.[3]

Companies' efficient TOTEX allowances for meter upgrades are thus determined through two interrelated assessments, one for the base cost element (BCA), and one for the enhancement element.[4] Both these assessments are new at PR24[5] and have not been consulted with the industry ahead of the draft determination.

[1] Ofwat (2024), 'PR24 draft determinations: Expenditure allowances', 12 July, p. 37.
[2] Ofwat (2024), 'PR24 draft determinations: Expenditure allowances - Enhancement cost modelling appendix, 12 July, p. 86.
[3] The BCA and enhancement assessment both make allowances for upgrades to new advanced metering infrastructure (AMI) and related meters. However, while the BCA also funds upgrades to automated meter reading, or AMR, meters, the enhancement assessment does not (at least not for all companies bar Dŵr Cymru).
[4] Illustratively, if a company's TOTEX meter replacement unit cost is £200 per meter, the like-for-like replacement cost element (say £110 per meter) will be assessed under the BCA and its technology upgrade element (£90 per meter) will be assessed under the enhancement model.
[5] At PR19, Ofwat only provided enhancement funding for new meter installations. See, Ofwat (2020), 'PR19 final determinations: Securing cost efficiency technical appendix', December, p. 83, available here and Ofwat (2019), 'Wholesale Water Enhancement feeder model: Metering' [Excel model], available here.

Affinity Water (AFW) has commissioned Oxera to review the respective elements of Ofwat's approach. Given the scale of smart metering programmes at PR24, and the complex, multilayered nature of Ofwat's assessment, we were asked to assess whether Ofwat's approach is sufficiently robust to ensure that companies receive the efficient cost allowances necessary to deliver the benefits stated in their WRMPs.

In summary, we have identified several shortcomings to Ofwat's approach, which risks significantly underfunding AFW's PR24 WRMP commitments. These shortcomings stem from the fact that Ofwat has incorrectly derived the volume of metering activity funded through its PR24 base cost models and at PR19, and relatedly, not conducted a like-for-like assessment across meter types and workload mixes in determining appropriate unit costs. The corrections and moderations required to Ofwat's approach, and the impact thereof, are as follows.

- **Removing the BCA PR19-under-delivery component**. Ofwat's PR19-under-delivery contention is poorly motivated and introduces a one-sided risk, retrospectively, with no compensation for outperformance. The PR19 under-delivery component should either be discarded[6], or at most could be derived using the same approach to Ofwat's PR24 implicit base allowance calculation. Addressing this issue by removing the 'under-delivery' element would increase the total number of explicitly funded meter upgrades for AFW from 62% to 79%[7]
- **Adjusting the PR24 'what base buys' replacement rate,** because: (i) it is not based on the relevant benchmark period (i.e. last 5 years), which is the determinant of funding (and not the entire modelling period,[8] as assumed by Ofwat), and (ii) it does not account for the fact that the historical replacement rate is not on a smart meter equivalent basis. Correcting for these elements would improve AFW's BCA funding to cover 80% of its planned upgrades as well as another 7.5k AMR-to-AMR meter replacements.
- **Adjusting the BCA (derived) median unit cost to be on a like-for-like basis**. Ofwat's current approach does not take into account

[6] Ofwat is asking companies to deliver on their PR19 business plan replacement forecasts but where eventual funding is from Ofwat's base cost allowances. In the absence of specific funding mechanism for metering at PR19 (e.g. via BCA with or without Price Control Deliverable), companies had discretion to achieve best possible outcomes within Ofwat's efficient cost allowances
[7] Or 77% of AFW's planned activity if they were only held to account to 'what base bought' at PR19 (what was implicitly funded from PR19 base cost models). AFW's total planned meter upgrades to AMR or AMI meters for PR24 are 347.39k.
[8] See discussions in-text and appendix section A3 on why this is the case.

company-specific complexity of workloads or the costs of different meter types. There are reporting inconsistency concerns, despite Ofwat's various reallocations (as illustrated from the wide variation in unit costs across companies). This could, in part, be ameliorated by excluding additional outliers (those with unfeasibly low derived unit costs), which would result in Ofwat's current median unit cost increasing by 12% to £144.33 per meter. This, however, still excludes company-specific workload mix considerations.[9] Based on their bottom-up assessment, AFW estimates that they would require an efficient weighted average unit cost of £229.32 per meter for like-for-like meter replacements (post Ofwat's job-and programme cost reallocations), given their relatively more complex workloads.

- **Moving to a more appropriate enhancement expenditure assessment.** As Ofwat acknowledged, its draft determination cost allowances included errors.[10] Once these errors are corrected, Ofwat's model estimates constant returns to scale and thus modelling on a unit cost basis would be more appropriate. Moreover, Ofwat's panel data model adds limited value (indeed, could be tracking noise) and aggregated (cross-sectional) models would be more appropriate.[11] Empirical evidence on the corrected model and precedent from Ofwat's modelling approach elsewhere suggest that it would be more appropriate to use (i) total period (i.e. aggregate) data for modelling under constant returns to scale and (ii) triangulate results with a median unit cost analysis. The impact of these corrections increases AFW's total enhancement model allowances across smart meter installations and upgrades from £53m to £56.7m.

[9] In terms of meter type, like household/non-household and AMR/AMI sub-types, as well as installation type—external screw-fix, external dig or internal installations/upgrades.
[10] Ofwat (2024), 'PR24 draft determinations: Expenditure allowances - Enhancement cost modelling appendix', p. 91, footnote 35.
[11] A median unit cost approach is more appropriate given constant returns to scale, consistency with Ofwat's broader approach, and as a way to address reporting concerns. The collapsed, aggregate models in turn are more appropriate because they can reduce the errors introduced by Ofwat's current panel data approach to estimating the relationship between costs and cost drivers.

Ofwat's approach

For new smart meter installations, costs are assessed using a panel data model with the volume of new meter installations as the sole cost driver.[12] The costs modelled follow Ofwat's reallocations, excluding outliers[13] and including smart metering infrastructure (SMI) costs (apportioned between new installations and upgrades, and over time by Ofwat).[14] For all companies except Dŵr Cymru (WSH),[15] this assessment funds for new advanced metering infrastructure (AMI) and related meter installation costs.

For meter upgrades, Ofwat conducts separate, but interdependent and sequential assessments for both base and enhancement expenditure elements. All upgrade costs that are not assessed under enhancement expenditure (including those reallocated from the enhancement model) are assumed to be funded through base expenditure, either implicitly or under the BCA. We summarise the main steps in the respective assessments below.

Step 1: Enhancement-to-base reallocations. Ofwat has reallocated expenditure based on its company query process, which involved removing all job- and programme costs from the meter upgrade enhancement assessment.[16] As part of this process, Ofwat reallocates c. 24% of the industry's £779.8m submitted enhancement upgrade costs to base expenditure (including SMI costs).[17] As shown in **Error! Not a valid bookmark self-reference.** below, the effect of the reallocation is to reduce the industry's median submitted enhancement unit cost from £110.74 to £86.19 per meter, by construction (excluding WSH[18]). Ofwat

[12] That is, companies' forecast costs over 2023/24 to 2029/30 are modelled against the number of new meter installations for each company and year.
[13] All Portsmouth Water's (PRT) observations, given data quality concerns, as well as other specific company-year observations that either (i) had zero observations for either costs or the quantity of meter upgrades, or (ii) where there is significant variation in the company's unit costs over time (e.g., three years of SES's data is removed given that that it has proposed significantly lower unit costs in these years (c. £72 per meter) compared to other years (up to c. £434 per meter)).
[14] See detailed discussion in Ofwat (2024), 'PR24 draft determinations: Expenditure allowances - Enhancement cost modelling appendix', 12 July, pp. 86–87 and the accompanying modelling sheets in Ofwat (2024), 'PR24-DD-W-Metering', 12 July.
[15] Ofwat has made adjusted allowances for WSH, based on its proposal for a large-scale automated meter reading (AMR), thus not AMI, enhancement programme.
[16] Ofwat (2024), 'PR24 draft determinations: Expenditure allowances - Enhancement cost modelling appendix', 12 July, pp. 86–87 and Ofwat (2024), 'PR24-DD-W-Metering' (sheet 'Base_allocations').
[17] Ofwat (2024), 'PR24-DD-W-Metering' (sheet 'Model cost – upgrades DD').
[18] WSH is excluded from the median enhancement unit cost calculation, as it does not have an equivalent upgrade programme to AMI meters. WSH is also excluded from Ofwat's subsequent median total- and base unit cost assessments in Ofwat (2024), 'PR24-DD-W-Metering' (sheet 'Output_Replacements_Cost').

states that the aim of the reallocations is to improve the comparability of data between companies and improve the quality of data used in the benchmarking process.[19]

Table 1 Enhancement costs submitted vs the subset assessed

	Submitted (in BP)		Post reallocation	
	TOTEX (£m)	**£/meter**	**TOTEX (£m)**	**£/meter**
Industry (median*)	779.8	110.74*	594.1	86.19*
AFW	95.7	294.97	28.5	88.01

Note: *Industry median unit costs presented for upgrades to AMI meters (thus excluding WSH). All costs include Ofwat's SMI cost allocations.
Source: Oxera calculations based on Ofwat enhancement model data.

Step 2: Enhancement efficient cost prediction: Ofwat models meter upgrade costs (post its reallocation) based on the volume of upgrades as the cost driver—similar to the new installations model (also excluding outliers identified by Ofwat[20]). The median unit cost from the assessment is £78.49 per meter (with a range around this value, depending on the scale of the company's programme given Ofwat's 0.98 cost-volume elasticity estimate).[21] As with new installations, for all companies except WSH,[22] enhancement expenditure only funds upgrades to AMI meters.

Step 3: Median base unit cost derivation. Ofwat derives the base unit cost for each company as (i) the total (base plus enhancement, or TOTEX) unit cost that companies submitted in their BPs,[23] less (ii) the median of the efficient enhancement unit costs estimated across companies in step 2 above. On this basis, Ofwat calculates the median

[19] Ofwat (2024), 'PR24 draft determinations: Expenditure allowances - Enhancement cost modelling appendix', p. 87.
[20] All PRT's observations are excluded, given Ofwat's data quality concerns, as well as other specific company-year observations that had zero observations for either costs or the quantity of meter upgrades in that year.
[21] Ofwat (2024), 'PR24-DD-W-Metering' (sheet 'Model cost – upgrades DD').
[22] Ofwat has made adjusted allowances for WSH, based on its proposal for a large-scale automated meter reading (AMR), thus not AMI, enhancement programme.
[23] This is a weighted average, across upgrades from basic and AMR meters and for residential and business customers, respectively. The weighted average TOTEX unit cost per company is thus based on the upgrade costs from basic or AMR to AMI meters, as reported in BP lines CW7.26 (for residential, basic-to-AMI), CW7.28 (business, basic-to-AMI), CW7.30 (residential, AMR-to-AMI) and CW7.32 (business, AMR-to-AMI), weighted by the corresponding volumes of meters. See Ofwat (2024), 'PR24-DD-W-Metering' (sheet 'Output_Replacements_Cost').

derived base unit cost across the relevant companies as £124.46 per meter. In the BCA, Ofwat has used a median unit cost of £128.89.[24]

The median unit cost for TOTEX (company submitted), enhancement (Ofwat estimated) and base (Ofwat derived) activities proposed in the draft determinations are presented in **Error! Reference source not found.** below.

Table 2 Median base unit cost derivation for BCA (£ per meter)

Unit cost	TOTEX	Enhancement	Base
	(submitted)	(median, predicted)	(TOTEX-Enhancement)
Industry median	202.96	78.49	124.46 [128.89*]
AFW	344.28	78.49	265.79

Note: *Applied median unit cost. All costs includes Ofwat's SMI cost allocations.
Source: Ofwat enhancement model, sheet 'Output_Replacements_Cost'.

Step 4: The BCA. Ofwat provides a total (explicit and implicit) allowance for companies' proposed meter upgrades, based on the £128.89 per meter noted above. The BCA provides explicit funding for metering volumes where Ofwat deems that companies have not already received implicit funding, either at PR19 or from the base cost models for PR24.[25] The implicit funding, in turn, consists of two parts and is derived as follows.

- **What base buys (WBB) at PR24:** Ofwat states that the WBB determines the number of meter replacements funded through its base cost models.[26] The WBB calculation is based on the industry average for (i) meter penetration and (ii) meter renewal rates over 2011–23 (i.e. the base cost modelled period), multiplied by each company's forecast of the total number of properties served over 2025–30 (for households and non-household customers, respectively).

[24] The use of £128.89 per meter may be due to the error that Ofwat has since recognised in the initial panel specification of the model, leading to incorrect cost predictions across companies (as discussed on p. 10 below).
[25] Ofwat (2024), 'PR24 draft determinations: Expenditure', pp. 38–40.
[26] Ofwat (2024), 'PR24 draft determinations: Expenditure, pp. 38–39.

- **PR19 'under-delivery' (previously funded)**: Ofwat calculates this as the difference between companies' initial PR19 forecast for meter replacements and the sum of delivered and forecasted (still to be delivered) replacements over the 2020–25 period. Any under-delivery of metering activity is excluded from the BCA, while over-delivery is ignored from the calculation.

Both the WBB and PR19 elements of the implicit allowance are subtracted from companies' PR24 forecast volumes, with the BCA providing funding for the residual 5.8m (or 75%) of the industry's 7.7m meters proposed over the period (as illustrated in **Error! Reference source not found.**, below).

Table 3 BCA explicitly funded meter upgrade volumes vs total

Unit cost	Total PR24 forecast	BCA explicitly funded	
	Nr of meters ('000s)	Nr of meters ('000s)	£m
Industry	7.711	5,811	749.0
AFW	347	215.43	27.77

Note: £m values based on unit cost of £128.89 per meter.
Source: Ofwat BCA model.[27]

In addition, while the BCA applies to *all* meter upgrades (including from basic-to-automated meter reading, or AMR, meters), the corresponding enhancement modelling assesses and funds only upgrades from basic to AMR or AMI meters (thus a mostly overlapping subset of the BCA funded meters). All companies except WSH thus, in effect, only receive funding for basic-to-AMR upgrades as if they were like-for-like meter replacements. Companies receive no BCA for other like-for-like meter replacements (like AMR-to-AMR). Ofwat argues that 'this avoids customers paying twice for meter replacement as these costs will be included in the future base expenditure allowances'[28] (though the historical replacement rate used in Ofwat's WBB calculation includes both upgrades and like-for-like replacements—discussed below[29]).

[27] Ofwat, (2024), 'PR24-DD-Meter-replacements-adjustment'.
[28] Ofwat (2024), 'PR24 draft determinations: Expenditure', p. 38.
[29] See sub-section 'Unjustified BCA implicit allowance assessment (post reallocations)', p. 12.

Errors, inconsistencies and suggested improvements

There are several shortcomings to Ofwat's assessment, some of which are overarching and others are specific errors or unjustified assumptions in the respective enhancement and BCA assessments. We discuss these in turn below.

Overarching lack of data granularity and reporting inconsistencies

There are three overarching shortcomings to Ofwat's assessment, all of which relate to the (over) simplifying assumptions made and the lack of granular, like-for-like underlying data relied on by Ofwat in its analysis:

- **The assessment fails to account for the varying installation activities across companies**. Our understanding is that companies have at least three different types of installations based on the locations of each meter installation/replacement: external screw-in, external dig or internal (i.e., within the home or company premises). This workload mix varies across companies, especially for the replacement (and upgrade) of existing meters. While Ofwat's information requests to companies as part of its cost reallocation process required companies to provide a breakdown of their unit costs on this basis,[30] it has not used this information to inform its assessment of the appropriate unit costs by type of workload and meter type.
- **Insufficient and/or incorrect consideration of differences in meter types**. Ofwat has assessed household (HH) and non-household (NHH) meters together, as part of the same enhancement and BCA models—thus allowing the same efficient unit cost for each. Ofwat does not sufficiently account for the fact that companies do not have similar HH/NHH workloads, and that NHH meters cost significantly more.[31] Ofwat has also not sufficiently distinguished between the different costs

[30] For example, in the related query and response to OFW-IBQ-AFW-003.
[31] In the one case where Ofwat has somewhat accounted for these HH/NHH differentials (in the weighting for its reallocation of upgrade costs from enhancement to base), it seems to have been done incorrectly or based on inconsistent reporting (discussed in appendix, section A1 below).

associated with AMR and AMI meters within its enhancement[32] or BCA assessments.[33] We understand from AFW that even within the respective HH and NHH meter categories, costs can vary up to ten-fold based on the meter sub-type.

- **Reporting inconsistency and data quality concerns.** Given that some companies had limited smart metering programmes at the time of BP submissions (in October 2023), their costing and reporting may be less reliable than others. For example, companies that have already started the rollout of their AMI meter programme and/or gone through competitive tender processes or secured contracts to do so, may have a more accurate assessment of the expected costs of their smart meter programmes. As discussed further in the appendix,[34] the TOTEX and enhancement unit cost values used by Ofwat to perform the upgrade cost-reallocations from enhancement to base expenditure[35] do not align with the unit costs implied per HH and NHH meter by the costs[36] and volumes[37] used in the actual cost assessment.

Given the interlinked nature of the smart meter upgrades assessment, and the uncertainty around what is base (like-for-like replacement) and enhancement (technology upgrade) costs, both elements of the upgrades assessment would be affected by the issues outlined above.[38]

The root cause for these overarching issues is a lack of granular and like-for-like data on which to undertake robust assessments. Our understanding is that Ofwat has started gathering some of this more granular data through its query process but it has not yet made it publicly available.[39] Such disaggregated information and a like-for-like assessment should form the basis of Ofwat's final determinations.

[32] In both enhancement models, WSH's AMR meter costs are modelled on the same basis as all the other companies (who have AMI programmes). While Ofwat applies a post-model correction for WSH (to account for the fact the AMR programmes cost less), by using WSH's data in the model, Ofwat potentially underestimates the AMI programme costs for other companies
[33] Ofwat's BCA assessment also allows a £128.89 per meter upgrade, irrespective of whether it is an AMR/AMI or HH/NHH meter.
[34] See appendix section A1.
[35] As reported in BP lines CW7.26 to CW7.33.
[36] As reported in BP lines CW3.74, CW3.77, CW3.83 and CW3.86.
[37] As reported in BP lines CW7.11 to CW7.14.
[38] If the unit costs used for these reallocations are incorrect, it would affect both Ofwat's estimated efficient enhancement and BCA median unit costs
[39] With reference to the company queries listed in cells D29:D45 in sheet 'Base_Allocations' of Ofwat (2024), 'PR24-DD-W-Metering'.

To address these overarching issues, in the sections below, we discuss some potential higher-level remedies, as they relate to the BCA and related reallocated enhancement expenditure data.

Enhancement model specification issues

Both the new installations and upgrade enhancement models suffer from the same specification issues:

- **the models estimate constant returns to scale** but this relationship is not implemented in the specification;
- **the panel structure is likely to introduce unnecessary noise/uncertainty** around the estimates (where differences within companies over time appear sporadic, and relevant variation is probably between companies).

First, Ofwat has noted that there is a discrepancy in the modelling results on which it has based the draft determinations[40] and those reported in the accompanying STATA outputs (reported in the corresponding feeder model Excel file[41]). We have replicated Ofwat's model[42] and compare the results to those published in the draft determinations in **Error! Reference source not found.** below:

[40] Ofwat (2024), 'PR24 draft determinations: Expenditure allowances - Enhancement cost modelling appendix', p. 91, footnote 35.
[41] Ofwat (2024), 'PR24-DD-W-Metering' (sheet 'Reg_outputs (STATA)').
[42] Based on the published STATA analysis file and description provided in the relevant annex.

Table 4 Ofwat modelling results, draft determinations vs corrected

	New installations		Meter upgrades	
Explanatory variable	Ofwat's DD	Oxera replication	Ofwat's DD	Oxera replication
Ln(Nr)	0.977***	0.987***	0.981***	1.000***
	{0.000}	{0.000}	{0.000}	{0.000}
Constant	5.969***	5.963***	4.454***	4.357***
	{0.000}	{0.000}	{0.000}	{0.000}
Adjusted R-squared	0.961	0.963	0.952	0.959
Observations	74	74	86	86

Source: Ofwat draft determination modelling coefficients, as reported, and Oxera replication based on Ofwat modelling files (aligned with Ofwat's 'STATA' reporting).

The differences in the model coefficients has two consequences for the enhancement expenditure determinations, as follows.

- Ofwat's published cost determinations are (marginally) incorrect, as they are based on the wrong model coefficients.[43]
- More importantly, the corrected model coefficients suggest that **constant returns to scale exists** for both the new installations or meter upgrades models.[44] This is contrary to Ofwat's initial conclusions, based on the incorrect estimates above.[45]

Constant returns to scale suggests that an alternative functional form would be more appropriate, like a unit cost model[46] or introducing a unit cost (ratio benchmarking) assessment. A unit cost approach would be appropriate, in particular, given that (i) it is consistent with Ofwat's approach elsewhere[47]; (ii) it is more consistent with Ofwat's broader smart meter assessment (with the BCA derived based on median unit

[43] Ofwat states this will be corrected for final determinations—see Ofwat (2024), 'PR24 draft determinations: Expenditure allowances - Enhancement cost modelling appendix', p. 91, footnote 35.
[44] That is, the coefficient of one on the volume of meters indicates constant returns to scale for upgrade (1% increase in the number of meters upgrades implies a 1% increase in cost). The coefficient is also not statistically different from one for new installations (the 95% confidence interval on the logged new meter numbers coefficient estimate is [0.93, 1.04].
[45] Ofwat (2024), 'PR24 draft determinations: Expenditure allowances - Enhancement cost modelling appendix', pp. 89–91.
[46] Modelling cost per meter as the dependent variable, similar to Ofwat's Retail models.
[47] For example, in the lead reduction enhancement modelling Ofwat uses both a univariate panel and median unit cost approach, based on the expectation of constant returns to scale. See further discussion in appendix section A2 and Ofwat (2024), 'PR24 draft determinations: Expenditure allowances - Enhancement cost modelling appendix', p. 95.

costs[48]); and (iii) it could ameliorate some of the reporting and data quality concerns (using a median would moderate the effect of outliers[49], whereas outliers can bias econometric model predictions if they are not excluded).

Additionally, in the current case, Ofwat's panel structure is most likely failing to identify the true variation in metering costs within companies over time, but rather tracking 'noise' (or measurement error) instead. This is introduced by cost-volume profiling mismatches and the fact that the costs assessed are more of a construct (of Ofwat's SMI allocations and other reallocations) than actual submitted annual costs.[50]

Below we present the results based on a more appropriate modelling approach, taking the weighted average across the proposed (i) median unit cost (i.e., ratio benchmarking) and (ii) cross-sectional versions of Ofwat's current econometric models for new installations and upgrades respectively under constant returns to scale.[51]

- **For new installations** this would result in changes in modelled allowances (i.e., efficient predicted costs) from £952m to £1,046m for the industry and from £27.52m to £30.26m for AFW.
- **For upgrades** this would result in changes in modelled allowances from £577m to £604m for the industry and from £25.51m to £26.41m for AFW.

Unjustified BCA implicit allowance assessment (post reallocations)

Ofwat's derivation of the (i) implicit volume of metering activity funded at PR24 and PR19, and (ii) median base unit costs elements of BCA are poorly justified and not on a like-for-like basis in terms of the types of meters being replaced, discussed in turn below.

There are at least two material errors associated with (i).

First, the PR19 under-delivery estimate is poorly motivated and goes against regulatory best-practice by introducing an unjustified, one-sided risk to companies for the following reasons.

[48] See step 3 on Ofwat's approach to metering upgrades assessment above.
[49] That is, as long as the median company's value is not affected by reporting concerns and is reflective of the true median unit cost.
[50] Further detail provided in appendix subsection A2.
[51] Further details can be found in appendix A2.

- Companies' PR19 meter replacement forecasts were not based on their eventual base cost allowances, but their (generally higher) planned expenditure submitted in their initial BPs. At most, using Ofwat's logic for the PR24 WBB estimate, companies were *funded* to achieve whatever was implicitly allowed through the base cost models at PR19 final determinations.
- Unlike PR24, companies did not receive specifically allocated funding for meter upgrades or replacements (in the form of a BCA, enhancement allowances[52] or price control deliverables) to deliver specific levels of meter replacements at PR19. Instead, companies were funded for their base expenditure activities to achieve certain outcomes (like demand reduction targets), and provided with the discretion to achieve these as best they could with their efficient cost allowances (and related outcome delivery incentives).
- Ofwat will be introducing a one-sided risk to companies and setting a poor regulatory precedent, by in effect retrospectively penalising what it is considering as 'under-delivery' while not similarly rewarding 'over-delivery'.

Second, the WBB estimate for PR24 is not comparing on a like-for-like basis. In addition to the overarching issues raised above,[53] the meter replacement rate used should at least:

- be based on the benchmarking period;
- be on a smart-meter equivalent basis; and
- account for the fact that companies still need to conduct like-for-like meter replacements at PR24 and beyond.

As in other areas where Ofwat is employing a similar WBB analysis (such as mains renewals), Ofwat is incorrect to assume that this implicitly funded rate is based on the average activity over the entire modelling period. While Ofwat uses data over 2011–23 to estimate its cost models, it benchmarks costs using company performance over the last five years of outturn data (2018–23 at draft determinations). Meter replacement activity is not included in Ofwat's cost models, i.e. it is an omitted variable. In its WBB analysis, Ofwat assumes that this omitted variable is uncorrelated with the cost drivers included in its cost model

[52] At PR19, enhancement allowances were only made for new meter installations.
[53] Note that these are in addition to the other overarching concerns highlighted above, that Ofwat should consider at a more disaggregated level types of meters renewed (e.g. basic, AMR and HH vs NHH), and that their associated workload costs (e.g., external screw fix, -digs, internal) are different across companies and time.

(if correlated, the implicit funding could differ by company). Following Ofwat's assumption, the cost impact of the omitted variable (i.e. meter replacement activity) feeds into the constant in the regression. However, the constant in the regression is adjusted based on the performance of companies in the benchmarking period, such that the benchmarking period (not the modelling period) is the determinant of what is implicitly funded.[54]

Illustratively, for HHs:

- Ofwat's current WBB total implied replacement rate is 0.85%.[55]
- Based on the more appropriate 2018–23 benchmarking period, this is 0.86%.[56]
- If one further accounts for the fact that a large share of historical replacements were basic-to-basic meter replacements undertaken at lower cost,[57] the notional smart meter equivalent replacement rate would be at most 0.83%.[58]

Table A5 shows the impact of moderating Ofwat's assumptions on estimates of the volume of relevant metering activity that is implicitly funded.[59] Specifically,

- Ofwat currently provides BCA allowances for 5.81m (or 75%) of the 7.71m planned meter upgrades over PR24.
- Removing the PR19 under-delivery component expands the BCA's funding to 6.45m meters (c. 83% of planned upgrades). The impact is similar when applying Ofwat's WBB analysis to the PR19 base cost models.[60]

[54] This is discussed in more detail in appendix section A3.
[55] That is, the industry average 52.7% penetration rate multiplied by the 1.6% renewal rate over 2011–23. See appendix **Error! Reference source not found.**.
[56] Over which there was a higher industry average penetration rate (58.22%) but lower replacement rate (1.48%).
[57] Based on the latest three years of APR data, basic meter renewals cost c. £106 per meter, 84% of the average cost of AMR and AMI meter renewals over the same period.
[58] The discounted total replacement rate accounts for the fact that basic-to-basic replacement costs are 84% of AMR and AMI renewals, and the fact that these replacements were at least 33% of total replacements over from 2020/21 and earlier. Given a lack of disaggregated cost data by meter type over the full historical period, this is based on the industry weighted average renewal cost for meter renewals over 2021/22–23/24 and some (conservative) simplifying assumptions, to illustrate the point. The smart meter equivalent calculation is discussed in more detail in appendix section A4.
[59] The table also shows illustrative £m values based on (i) Ofwat's inappropriate unit cost of £128.89 per meter and (ii) the median unit cost of £144.33 when excluding outliers.
[60] The BCA funding would cover 6.38m meters in this case (also 83% of total requested), with the PR19 WBB implicit allowance based on the PR19 base cost models' benchmark period (2014/15-2018/19).

- Using the benchmark period (2018–23) and accounting for the fact that historical replacement rates should be on a smart-meter equivalent basis expands the BCA funding to cover 6.50m meters (84% of the industry's total planned).

Lastly, the historical industry average replacement rate that Ofwat uses to construct the WBB estimate includes both like-for-like replacements *and* upgrades.[61] Should Ofwat require companies to achieve the same historical rate at PR24, it should recognise what like-for-like replacements contribute to achieving this replacement rate (and remain necessary for companies, and areas where smart meter rollout has not occurred yet).

Further, Ofwat needs to revisit its median unit cost derivation to:

- **take into account company-specific complexity of workloads and costs of different meter types**; and
- **exclude other outliers** with extremely low derived base unit costs to deal with reporting concerns (especially if Ofwat is not able to conduct the more granular assessment based on companies' specific meter types and workload mixes discussed above).

The data to correct for company-specific workloads and meter types is not publicly available, so we focus on the impact of excluding outliers here. However, we note that based on a bottom-up assessment, AFW estimates that they would require £229.32 per meter for like-for-like meter replacements (post Ofwat's job-and programme cost reallocations), given their relatively more complex workloads.[62]

Regarding outliers, in addition to WSH (that has a base unit cost of £35.93), there are two other companies with similarly low meter replacement costs of £44.06 and £45.50 per meter (SSC and SES, respectively). [63] These rates are significantly lower than Ofwat's current

[61] Otherwise, Ofwat would implicitly require a higher total replacement rate at PR24, with like-for-like replacements remaining unfunded.
[62] See AFW's response to question 9.1 of Ofwat's draft determination enhancement modelling consultation questions.
[63] Both SSC and SES also have very low TOTEX unit costs of £122.55 and £123.99 per meter, respectively. Comparable to WSH's £112.42 per meter (which is based on a programme of only upgrading to lower cost AMR meters). See unit costs reported in Ofwat (2024), 'PR24-DD-W-Metering' (sheet 'Output_Replacements_Cost').

derived base unit costs for other companies, which ranges between £77.84 to £265.79 per meter (when excluding WSH, SSC and SES).

SSC and SES's derived base unit costs are also much lower than the industry average unit cost for basic HH meter renewals over the last three years (2022–24) of £106.72 per meter.[64] This suggests that SSC and SES's planned unit costs, as a weighted average across all types of like-for-like replacements (HH/NHH, AMR/AMI, etc.), are **less than half the current actual least cost type of meter replacement** (over the last three years' outturn). These companies may have mis-calibrated their costs and/or there are reporting inconsistencies and errors that need to be corrected to ensure that the like-for-like replacement programme can be funded at the appropriate unit cost.

Excluding SSC and SES as outliers would increase Ofwat's median derived unit costs to £144.33 per meter. Applying this rate to the BCA would change the amount of funding from Ofwat's current BCA to the industry by 12% (and up to 25% when including the corrections to the implied volume allowance discussed above).

We summarise the combined impact of the total improvements proposed in Table 5 below (and in more detail across the scenarios in Table A5 in the appendix).

Table 5 AFW's BCA allowances for under the suggested approaches

Scenario	Period	WBB benchmark	PR19 'under-delivery'	Unit cost	BCA funded	
					nr ('000s)	£m
1. Total submitted					347.39	
2. BCA funded						
Ofwat	2011–23	Industry	PR19 forecast	Ofwat (£128.89)	215.43	27.77
Oxera proposal	2018–23	Industry (smart meter eq.)	None	Excl. outliers (£144.33)	278.34	40.17
Oxera proposal + AFW unit rate	2018–23	Industry (smart meter eq.)	PR19 WBB 'funded'	AFW unit rate (£229.32)	278.34	63.83

Source: Oxera analysis based on Ofwat BCA model and APR data.

[64] Based on APR data over 2021–24, as reported in line 6D_24_11_4 (costs) and 6D_24_17_4 (volumes).

Finally, AFW has also submitted 7,525 like-for-like meter renewals that are not accounted for above.[65] We understand that these like-for-like AMR replacements are in areas where the digital infrastructure upgrades required for AMI metering is not possible. [AFW to add further justification if relevant]

Based on Ofwat's current BCA, like-for-like meter replacement cost of £128.89 per meter, AFW would thus require another £0.97m of funding for these additional replacement. As discussed above, these meters are over-and-above what is required by Ofwat's WBB implicit allowance (which is based on the *total* historical meter renewal rate, and should thus include these meters).

[65] The total meter renewals over 2025–30 reported in AFW's BP, line CW7.9 are 338,913, of which 331,388 are the upgrades reported under lines CW7.11-14. Only the latter are assessed under Ofwat's BCA assessment (note that this excludes the 16,000 Accelerated programme meters, which takes AFW's total under the BCA to 347,388).

Appendix

A. 1 Details on reporting concerns and lack of granularity in data

The TOTEX and enhancement unit cost used by Ofwat to reallocate upgrade costs from enhancement to base expenditure is clearly not a reliable basis on which to do so (this affects both Ofwat's estimated efficient enhancement and BCA median unit costs). These values are hard coded in the BPs[66] and it is not clear that companies have reported them on a consistent basis. For example, these values do not align with the unit costs implied per HH and NHH meter by the forecast costs[67] and volumes[68] used in Ofwat's actual cost assessment.

We understand that these are companies' average notional unit costs per meter upgrade type (e.g., HH basic-to-AMI, NHH AMR-to-AMI), but they clearly are not granular enough and do not map to the actual planned costs and volumes submitted in companies' BPs. For example, on the basis of these hard coded unit costs (and subsequent information requests), Ofwat estimates the AFW's NHH to HH enhancement cost ratio is 1.64.[69] However, based on the actual costs and volumes submitted in the BP (and assessed in Ofwat's models) the ratio is 2.43 (c. £250 for the average HH meter upgrade to AMI, and c. £607 for the average NHH upgrade).

There is also significant variation in the upgrade to smart meter (AMI) unit costs submitted (all excluding WSH):

- Companies' enhancement unit costs (post reallocations) still vary significantly, between £43.56 to £115.04 per technology upgrade.[70]
- Companies' TOTEX unit costs vary between £122.55 per meter and £344.28 per meter.

[66] As reported in BP lines CW7.26 to CW7.33.
[67] As reported in BP lines CW3.74, CW3.77, CW3.83 and CW3.86.
[68] As reported in BP lines CW7.11 to CW7.14.
[69] Ofwat (2024), 'PR24-DD-W-Metering' (sheet 'Base-allocations', cell I40).
[70] This excludes WSH (given that it does not have an AMI programme) and PRT, who has an enhancement unit cost of £288.60 per meter upgrade (who did not provide the necessary data for Ofwat to do similar breakdown of its costs and quantities—see Ofwat (2024), 'PR24 draft determinations: Expenditure allowances - Enhancement cost modelling appendix', p. 87).

- There are thus similar levels of variation in the derived base unit costs, between £44.06 and £265.79 per meter.[71]

This confirms these reporting concerns and/or that other factors not accounted in Ofwat's models, like company workload mixes (meter types, job location, etc), are driving differences in company costs.

A.2 Correcting for enhancement model specification issues

Below we provide more detail in the alternative analysis suggested, to correct for the limitations covered in the main text from the original model proposed by Ofwat. In particular, we look at the following two variations:

- modelling allowances based on a median unit cost model;
- specifying the econometric model as a total period (i.e. aggregated) model instead of a panel.

The rationale for the median unit cost approach, as discussed above, is that Ofwat's corrected panel model estimates suggests that there is constant returns to scale for both smart meter upgrades and new installations. Therefore, contrary to Ofwat's initial conclusions (based on incorrect estimates), this indicates that an alternative functional form would be more appropriate. Two alternative (and more appropriate) approaches would be a unit cost model[72] or introducing a unit cost (ratio benchmarking) assessment.

The unit cost approach in the context of constant returns to scale could be more appropriate for the following reasons:

- **It is consistent with Ofwat's approach to lead reduction**. In the lead reduction enhancement assessment, Ofwat triangulates across results from a panel data model (similar to metering) and industry median unit cost—given that Ofwat does not *expect* to find economies of scale.[73].
- **It is consistent with the broader smart meter assessment**. The BCA derived unit cost is based on the median company.[74]

[71] Ofwat (2024), 'PR24-DD-W-Metering' (sheet 'Output_Replacements_Cost').
[72] Modelling cost per meter as the dependent variable, similar to Ofwat's Retail models.
[73] Even if the lead panel modelling results suggest that there are indeed increasing returns to scale (in contrast to the case here). See Ofwat (2024), 'PR24 draft determinations: Expenditure allowances - Enhancement cost modelling appendix', p. 95.
[74] See step 3 on Ofwat's approach to metering upgrades assessment above.

- **It would ameliorate some of the reporting and data quality concerns**, moderating the effects of outliers.

Ofwat's panel data model adds limited value to the modelling, given likely mismatches in the profiling of costs (like fixed upfront SMI setup costs) and when the corresponding metering volumes are eventually delivered. This is exacerbated by Ofwat's allocation of SMI costs across time and reallocations of companies' submitted costs, such that the annual unit costs assessed in the panel model is more based on Ofwat's reconstruction of the data and cost-volume profiling mismatches (than actual variation in companies' unit costs across time). This is evident from the unreasonably large variation in companies' unit costs over time,[75] and the fact that there is either missing costs or volumes for certain companies' years (while there are corresponding volumes or costs reported).[76]

It would be more appropriate for Ofwat to consider a collapsed model (i.e. total costs modelled against total volume of meters per company), that focusses only on the variation between companies. As shown in Table A 1 below, these models perform well statistically for both new installations and upgrades (with a high model fit, as shown in the high R-squared value, and the highly significant coefficient signs).

[75] For example, for new installations Ofwat removes three years of data for SES, given that it has proposed significantly lower unit costs in these years (c. £72 per meter) compared to other years (up to c. £434 per meter). While the large volatility in SES's unit costs could indicate data errors, Ofwat does not apply this logic evenly across companies. For example, Severn Trent England's (SVE's) unit costs are similarly volatile, with a lowest unit cost of c. £92 and a highest unit cost of c. £396, yet Ofwat does not treat this observation as an outlier.
[76] For example, this is the case in new installations for SEW in 2026 and 2027 and AFW in 2024.

Table A 1 Modelling results, collapsed version

	New installations	Meter upgrades
Explanatory variable	Collapsed model	Collapsed model
Ln(Nr)	0.946*** {0.000}	0.987*** {0.000}
Constant	6.158*** {0.000}	4.431*** {0.000}
Adjusted R-squared	0.957	0.954
Observations	15	16

Note: Brackets indicate p-values, and *** indicates significance at p<0.01 level.
Source: Oxera analysis based on Ofwat draft determination model data.

Below we present the results if Ofwat were instead to base its assessment on the proposed (i) median unit cost and a (ii) collapsed (or aggregated) version of Ofwat's current loglinear models, for new installations and upgrades respectively.

Table A2 below presents the findings for new installations, comparing the resulting modelled allowances from each alternative model relative to the TOTEX requested in companies' business plans. The median submitted unit cost (excluding WSH and PRT) is £436.7 per meter, and the median efficient predicted unit cost from the collapsed (or aggregated) model is £412.4 per meter. All three alternative models would result in an increase in total efficient predicted costs (or modelled allowances) for the industry and AFW.

Table A2 Allowances for new installations across alternative models (£m)

	Assessed	Efficient predicted			
	Post reallocations	Ofwat (panel)	Median unit cost	Collapsed model	Average of median UC & collapsed
Industry	1,022	952*	1,155	952	1,046
AFW	34.8	27.5	31.8	28.7	30.3

Note: Modelled allowances above excludes TMS deep dive allowances.
Source: Oxera analysis based on Ofwat draft determination model data.

We replicate the same analysis for upgrades, as presented in Table A 2. For upgrades the median submitted unit cost (excluding WSH and PRT) is £84.62m and the median efficient predicted unit cost from the collapsed model is £81.26 per meter. As for new installations, the resulting efficient predicted costs increase for the industry and AFW. Our preferred model results in total modelled allowances of £604m for industry and for AFW modelled allowances- £26.41m.

Table A3 Allowances for new upgrades across alternative models (£m)

	Assessed	Efficient predicted			
	Post reallocations	**Ofwat (panel)**	**Median unit cost**	**Collapsed model**	**Average of median UC & collapsed**
Industry	594	577	648	577	604
AFW	28.5	25.5	27.4	25.4	26.4

Source: Oxera analysis based on Ofwat draft determination model data.

A.3 The appropriate WBB implicit allowance benchmark period

A critical issue with Ofwat's assessment of WBB that is common across several of Ofwat's post-modelling adjustments is that the implicitly funded level of activity is estimated as the industry average activity throughout the modelling period (2011/12–23).

In essence, Ofwat's post-modelling adjustments amount to an 'omitted variable' problem—there is some driver of expenditure (e.g. meter replacement activity) that Ofwat acknowledges influences costs, yet is not accounted for in the econometric model. Therefore, we can assess the implicit allowance by examining how an omitted variable influences the cost models and subsequently a company's efficient expenditure.

First, we assume that the omitted driver is uncorrelated with the cost drivers included in the models. In this case, the omitted driver can be treated as a random, weakly positive variable. Suppose Ofwat's models are otherwise unbiased and that there is only one omitted factor. The true cost function is:

$$\ln(Cost_{it}) = \beta_0 + \beta_1 * \ln(Cost\ driver_{it}) + \gamma * (Omitted\ driver_{it}) + \varepsilon_{it}$$

Where:

- $Cost_{it}$ is the observed cost of company i at time t;
- $Cost\ driver_{it}$ is the observed cost driver of company i at time t;
- $Omitted\ driver_{it}$ is the observed omitted driver of company i at time t;
- ε_{it} is statistical noise for company i at time t.

However, Ofwat estimates the following regression.

$$\ln(\widehat{Cost_{it}}) = \widehat{\beta_0} + \widehat{\beta_1} * \ln(Cost\ driver_{it})$$

Where the 'hat' indicates that these are estimated values of the true parameters. Given that we have assumed that the omitted driver is uncorrelated with the cost drivers in the model, the estimated $\widehat{\beta_1}$ is unbiased. However, the estimated $\widehat{\beta_0}$ **is** biased, as it contains the cost impact of the average omitted activity over the modelling period, i.e. the implicitly funded level of the omitted activity. In this stylised case, it would be broadly appropriate to determine the implicitly funded level of activity as the industry-average activity over the period (i.e. Ofwat's approach at the DD).

However, this stylised case is unlikely to accurately reflect the current context. For example, the stylised case assumes that the cost drivers are uncorrelated with the omitted factor. If, instead, there is a strong correlation between the cost drivers and the omitted factor, then the estimated coefficient on the cost driver (i.e. $\widehat{\beta_1}$) would be biased. Specifically, the estimated coefficient would capture some of the cost impact of the omitted driver, such that the implicitly funded level of activity would differ by company depending on the value of that cost driver. Nonetheless, assuming that the omitted factor is uncorrelated with the cost drivers may be an appropriate and proportionate simplifying assumption in some cases. For example, we found that meter renewal activity is not correlated with the cost drivers included in Ofwat's models, such that it may be simpler and more appropriate to assume that the driver is uncorrelated.

More importantly, while the constant in Ofwat's regression analysis is estimated using the modelling period (2011/12–23), the constant that is used to set allowances is adjusted and determined by the benchmarking period (2018/19–23). This is because Ofwat adjusts allowances based on the performance of companies in the last five years, such that Ofwat's estimated efficient cost function is not necessarily the pure output from the regression. Instead, while the coefficients of the cost

drivers are indeed the pure output from the regression, the constant is adjusted based on the performance in the last five years. Given that the value of the constant is entirely informed by companies' performance in the last five years, the implicitly funded level of activity is also the industry average over the last five years (again, assuming that the omitted activity is uncorrelated with the cost drivers).

Given that Ofwat corrects to the upper-quartile benchmark, the degree to which the omitted activity is implicitly funded is technically driven by the average activity of the upper-quartile company. However, we do not consider that it would be appropriate to determine what is implicitly funded on the basis of one company, given that:

- strictly speaking, companies would be funded for all of the omitted factors related to the upper-quartile company, not just the omitted activity in question;
- the company may also have undertaken an exceptionally low or high level of the omitted activity as a direct decision of management, given prior flexibility on what companies were able to direct funding to;
- relying specifically on the benchmark company may result in unjustified volatility if there are any changes to the model specification or the benchmark stringency.

For these reasons, we consider that it is appropriate to assess the implicitly funded level of activity on the basis of the industry-average performance during the benchmark period, unless there is sufficient evidence that the omitted activity is strongly correlated with the cost drivers included in the models.

A.4 Suggested improvements to the BCA implicit allowance estimate

Below we show the impact of various more appropriate assumptions to Ofwat's implicit allowance assessments, as one introduces them incrementally (here focussing on the industry-level results, corresponding with AFW impacts reported in Table A5):

- Scenario 1: Assuming no PR19 'under-delivery' adjustment would increase the industry's volume of funded meter replacements from 5.81m to 6.43m (or from 75% to 83% of the total 7.7m

meters upgrades planned). The BCA allowance increases from £749.0m to c. £829.1m assuming Ofwat's current unit rate.[77].

- Scenario 1a: Assuming that the PR19 delivery target should (at most) be what companies were implicitly funded from PR19 models[78] increases the BCA funded volumes to 6.38m and -allowance to £797m.
- Scenario 2: Scenario 1 plus reducing the WBB period to the five-year benchmark period (2018–23) further increases the BCA funded volumes to 6.45m and -allowance to £831.5m.
- Scenario 2a: Scenario 1a plus reducing the WBB period to the five-year benchmark period (2018–23) increases the BCA funded volumes to 6.20m and -allowance to £799m.
- Scenario 3: Scenario 2 plus adjusting the historical replacement rate to be on a smart meter equivalent basis increases the BCA funded volumes to 6.50m and -allowance to £838.4m.
- Scenario 3a: Scenario 2a plus adjusting the historical replacement rate to be on a smart meter equivalent basis increases the BCA volumes to 6.29m and -allowance to £811m.
- Scenarios 5 to 5d shows the equivalents of the above, but excluding outlier companies (SSC and SES) from Ofwat's median base unit cost derivation (increasing the value to £144.33 per meter).

BCA smart-meter equivalent replacement rates

We suggest that Ofwat adjust the WBB implicit allowance (and in particular the underlying replacement rate used) to take into account the fact that a large share of companies historical replacement activity concerned lower cost, basic-to-basic meter replacements. In PR24, Ofwat currently only plans to fund upgrades to higher cost AMR and AMI meters through the BCA. The historical replacement rate would thus underfund these higher-cost renewals, if companies could afford to renew more meters over the relevant historical period because they were lower cost (on a weighted average basis).

To see why this is the case, by way of a simplified example:

- Assume a company had a £1,000 budget over 2018-23 for meter replacements, and a total of 1,000 meters installed. Say a basic-

[77] Scenarios 1 to 3 all assume Ofwat's current unit rate of £128.89 per meter.
[78] I.e., Ofwat's WBB approach but based on industry average over the PR19 benchmark period (2014/15 to 2018/19).

to-basic meter replacement costs £100 per meter and a similar like-for-like replacement for a smart meter is £200 per meter. If the company thus chose to spend its budget by replacing 30 basic meters (at a cost of £300) and 35 smart meters (the remaining £700), it would have achieved a replacement rate of 0.65%.[79]

- Assume that over 2025-30 the company has the same £1,000 meter replacement budget and total number of installations, but now only replaces smart meters (at the same cost). It would thus only be able to make 50 like-for-like smart meter replacements, and thus have a replacement rate of 0.5%.

Ofwat therefore needs to adjust the historical replacement rate to be on a smart-meter equivalent basis, for the same reason: to reflect the fact that historical replacement rates reflects a lower cost activity mix (the weighted average of historical replacement and upgrade costs) than what is expected at PR24. This reflects the fact that in practice the BCA is inevitably a £m allowance (or 'budget'), and not an allowance for a volume of meters.

To correct for this, one should take into account relative costs of basic, AMR, and AMI renewals. As an illustration of how one could go about this, below we provide a description of the methodology that could be used to make such an adjustment, and the (conservative) simplifying assumptions that we have made where historical data is not available.

First, we adjust historical industry meter replacement rates down to be on a smart-meter equivalent basis. For this analysis we have drawn from historical APR data. It's important to note, however, that the last three years of APR data (2021/22–2023/24) exhibits some volatility. We thus consider the full-period average unit costs across the industry, to smooth out any year- or company-specific volatility or profiling mismatches between when costs are incurred and volumes delivered.

We account for the fact that basic meter renewals were on average 84% of the cost of smart meter renewals over the latest three years of outturn, 2021-24, and make up a greater share of historical replacements. We have drawn from historical data to estimate the industry average unit costs for basic and smart (AMR/AMI) meters. From

[79] The 65 meters replaced over the total of 1,000 meters installed.

this we derive that the ratio of basic relative to smart meter unit cost replacement is of 84%, with £106.72 and £126.53 unit cost respectively.[80]

Subsequently, we have estimated an adjustment factor considering the unit cost by meter types, and a replacement profile by year of basic meters relative to the total renewal rate. To construct this replacement profile we have taken the ratio of basic meter renewal and total meter renewal for 2021/22 and 2022/23 (33% and 8% respectively). We do not have historical data on the breakdown of renewals by meter type, therefore we roll this renewal profile backwards by assuming a conservative 33% renewal rate up to the assumed start of the first smart meter roll out programmes across the industry (2015/16). For earlier years we have assumed that 100% of renewals were for basic meters.

Given the renewal profile and unit cost ratio, we estimate the adjustment factor as follows:

$$Adj.factor = \frac{(Replacement_t^{basic} \times UC_{basic} + (1 - Replacement_t^{basic}) \times UC_{smart}}{UC_{smart}}$$

With this smart metering adjustment, we have estimated the smart meter equivalent renewal rate for the industry. Table A4 Meter renewals implied by industry benchmark with and without smart-meter equivalent unit cost adjustment (HHs only)below reports the impact of this smart meter adjustment on the share of HHs requiring renewals per annum, according to Ofwat's WBB implicit allowance approach.[81]

[80] For the smart meter subsets the unit cost for renewals is of £126 and £127 for AMR and AMI respectively.
[81] Note that this analysis has been done for HH renewal rates only, given that we do not have data available for NHH renewal rates.

Table A4 Meter renewals implied by industry benchmark with and without smart-meter equivalent unit cost adjustment (HHs only)

	Penetration rate	Renewal rate		Share HHs renewed	
Period	**Industry (all)**	**Industry (all)**	**Industry (smart eq.)**	**Industry (all)**	**Industry (smart eq.)**
2011/12–2022/23 (Ofwat)	52.74%	1.61%	1.46%	0.85%	0.77%
2018/19–2022/23 (Benchmark period)	58.22%	1.48%	1.42%	0.86%	0.83%

Source: Oxera analysis based on Ofwat draft determination model data.

Moreover, the impact of this smart meter equivalent adjustment on the £m BCA to AFW and the industry, respectively, is reported on scenarios 3 and 3a (as well as 4c and 4d) of Table A5 below.

Table A5 Allowances for upgrades across alternative models

Scenario	PR24 WBB benchmark	Period	PR19 'under-delivery'	Unit cost	BCA funded	AFW		BCA funded	Industry	
					nr ('000s)	£m	% change	nr ('000s)	£m	% change
1. Total submitted					**347.39**			**7,712**		
2. BCA funded										
Ofwat	Industry	2011–23	PR19 forecast	Ofwat (£128.89)	215.43	27.77		5,811	749.0	
1	Industry	2011–23	None	Ofwat (£128.89)	274.55	35.39	27.4%	6,433	829.1	10.7%
1a	Industry	2011–23	PR19 'funded'	Ofwat (£128.89)	267.05	34.42	24.0%	6,376	796.8	6.4%
2	Industry	2018–23	None	Ofwat (£128.89)	275.25	35.48	27.8%	6,451	831.5	11.0%
2a	Industry	2018–23	PR19 'funded'	Ofwat (£128.89)	267.74	34.51	24.3%	6,201	799.2	6.7%
3	Industry smart meter eq.	2018–23	None	Ofwat (£128.89)	278.34	35.87	29.2%	6,505	838.4	11.9%
3a	Industry smart meter eq.	2018–23	PR19 'funded'	Ofwat (£128.89)	275.14	35.46	27.7%	6,293	811.0	8.3%
4	Industry	2011–23	PR19 forecast	Excl. outliers (£144.33)	215.43	31.09	12.0%	5,811	838.7	12.0%
4a	Industry	2018–23	None	Excl. outliers (£144.33)	275.25	39.73	43.1%	6,451	931.1	24.3%
4b	Industry	2018–23	PR19 'funded'	Excl. outliers (£144.33)	267.74	38.64	39.2%	6,201	894.9	19.5%

Scenario	PR24 WBB benchmark	Period	PR19 'under-delivery'	Unit cost	BCA funded	AFW		BCA funded	Industry	
					nr ('000s)	£m	% change	nr ('000s)	£m	% change
4c	Industry smart meter eq.	2018–23	None	Excl. outliers (£144.33)	278.34	40.17	44.7%	6,505	938.9	25.4%
4d	Industry smart meter eq.	2018–23	PR19 'funded'	Excl. outliers (£144.33)	275.14	39.71	43.0%	6,293	908.2	21.3%

Source: Oxera analysis based on Ofwat BCA model and APR data.

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