Northern Gas Networks

A31 - NGN RIIO-2

Outperformance Wedge

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OUTPERFORMANCE WEDGE

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EXECUTIVE SUMMARY

Context

In the RIIO GD2 Sector Specific Methodology Decision, Ofgem has proposed reducing its baseline estimate of the cost of equity by 50 bps.[1] According to Ofgem, this is to account for anticipated outperformance by licensees with respect to regulatory targets. At this stage of the price control process, the value of the adjustment, i.e. 50 bps, is a working assumption, to be reassessed at the final determination on the basis of consultation responses, additional evidence and an assessment of the final overall RIIO-2 proposals.

While Frontier is of the firmest view against the principle of setting a wedge on the allowed return on equity, to the extent that Ofgem is minded to carry out such an adjustment then it is necessary to quantify the outperformance wedge robustly.

This report sets out the work that Frontier has carried out to estimate a plausible range for the expected financial outperformance for a notional GDN based on a forensic bottom up review of price control incentives data. We note that a similar bottom up analysis has not been conducted by Ofgem in arriving to its 50bps estimate and in this regard our work is novel and is intended to move the debate on this adjustment forward, notwithstanding the wider debate around the merits of making such an adjustment at all.

Approach

Our approach for estimating a rage of expected outperformance is comprised of three steps:

1. We first identify the RIIO-GD2 incentives that may generate over or underperformance and estimate their target levels in RIIO-GD2;
2. Using historical data where possible, we estimate the potential performance against the target levels and correlation between the different incentives performance.
    a. Where historical data is unavailable we have developed plausible assumed correlations, with scenario testing to confirm reasonableness.
3. We simulate the incentive-level and overall performance for a notional company in RIIO-GD2 using a Monte Carlo simulation analysis.

While we rely as far as possible on historical data to inform our modelling, given the nature of the task we attempt here – essentially to predict the likely distribution of future outperformance – a wide range of supporting assumptions must be made. Having made some set of assumptions however, this framework allows us to go on to calculate what it would mean for expected outperformance. In particular this

[1] RIIO-2 Sector Specific Methodology Decision, 24 May 2019. Available at https://www.ofgem.gov.uk/system/files/docs/2019/05/riio-2_sector_specific_methodology_decision_-_core_30.5.19.pdf.

modelling framework is useful as it allows us to explore what one would need to believe in order for a 50 bps downward adjustment to be justified.

Results

Our core modelling scenario suggest that the average GDNs in GD2 should expect to underperform by 27 bps. This result arises as a result of:

- Our neutral modelling assumptions around totex (i.e. where we assume that Ofgem will be successful in setting targets that leave no expected outperformance for the average firm);
- Our assumption that ODI targets set at an upper quartile level, which by definition would then not be met by an average firm; and
- Owing to a number of downside only instruments (e.g. GSOP).

These results are broadly robust to a range of different assumptions, including alternative calibration of ODIs, Business Plan Incentives and Emergency Response Time incentives, correlation between incentives and RAV/Totex ratios.

Clearly the treatment of totex outperformance is a key determinant of this finding. However, it is important to stress that we use our main assumption in respect of totex as a base assumption from which to derive what is perhaps the more interesting result, i.e. what level of average totex outperformance would one need to expect to see in order for it to be valid to assume a 50 bps expected outperformance wedge. The answer is that a very large and sustained average outperformance – 9% across the sector in aggregate over the period - needs to be assumed. It feels incongruous to say the least to simultaneously take the view that Ofgem will strive to set stretching targets for the entire sector, while at the same time assuming an outperformance wedge that can only be justified by assuming totex outperformance from the entire sector at 9%. Ofgem will need to square this circle if it intends to maintain its position on the 50 bps.

Conclusions

Overall, following a detailed modelling investigation into all of the incentive mechanisms that we understand will be included in the GD2 framework, we have not identified a reasonable basis on which one could assume that an average GDN can be expected to outperform by 50 bps in RoRE terms.

There are of course limits to our modelling as a result of:

- data limitations;
- limitations on the level of explanation Ofgem has so far provided on how it intends some incentives to be calibrated and operated; and
- the inherently uncertain nature of outcomes of incentive mechanisms.

The exact choice of the assumptions can of course be subject to debate and potentially further study. However, we consider that this study can serve as a starting point for the regulator to robustly assess companies' potential outperformance within the price control. Should Ofgem set out further details of how certain instruments will be set up, this can be incorporated into our modelling.

Finally, we note that one interpretation of our finding of expected underperformance may be that rather than applying a deduction to the headline cost of equity, Ofgem should apply an uplift. We would encourage the reader not to reach this view. We disagree in principle with Ofgem's proposition that the allowed return on equity should be adjusted to account for expected outperformance (or indeed under-performance).

2 CONTEXT AND INTRODUCTION

In the RIIO GD2 Sector Specific Methodology Decision, Ofgem has proposed reducing the allowed cost of equity by 50 bps.[2] According to Ofgem, this is to account for anticipated outperformance by licensees with respect to regulatory targets. At this stage this is a working assumption, to be reassessed at the final determination on the basis of consultation responses, additional evidence and an assessment of the final overall RIIO-2 proposals.

For the avoidance of doubt, Frontier has previously argued against the principle of setting an arbitrary "outperformance wedge" on allowed equity returns. This is for a wide variety of reasons, including:[3]

- The proposed adjustment would create a link between current performance outturn and future return on capital, thereby undermining incentives to make outperformance in the first place and leading to lower levels of dynamic efficiency.
- It would lead to a headline figure for the cost of equity that would not reflect Ofgem's assessment of the true cost of equity, thereby undermining a key incentive for investment.
- Ofgem's arbitrary adjustment undermines past stability and predictability of the UK regulatory model and would weaken investor confidence to the detriment of customers.
- The proposal of a 50bps reduction is arbitrary, not based on robust analysis and reliant on selective data.

While Frontier is of the firmest view against the principle of setting a wedge on the allowed return on equity, to the extent that Ofgem is minded to carry out such an adjustment then it is necessary to quantify the outperformance wedge robustly.

This report sets out the work that Frontier has carried out to estimate a plausible range for the expected financial outperformance for a notional GDN based on a forensic bottom up review of price control incentives data. While some of the calibration of the parameters in this study is based on NGN specific data, we consider that our qualitative results would apply more generally to the sector (i.e. our work should not be understood to apply solely to NGN). This is because our modelling represents a notional GDN under RIIO GD2 framework as set out in Ofgem's methodology document, and our assumptions on targets and performance are not based on NGN-specific values.

We note that a similar bottom up analysis has not been conducted by Ofgem in arriving to its 50bps estimate and in this regard our work is novel and is intended to move the debate on this adjustment forward.

In summary, our approach for estimating a rage of expected outperformance is comprised of three steps:

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[2] RIIO-2 Sector Specific Methodology Decision, 24 May 2019. Available at https://www.ofgem.gov.uk/system/files/docs/2019/05/riio-2_sector_specific_methodology_decision_-_core_30.5.19.pdf.

[3] See Frontier Economics (2019): Adjusting Baseline Returns for Anticipated Outperformance

1. We first identify the RIIO-GD2 incentives that may generate over or underperformance and estimate their target levels in RIIO-GD2;
2. Using historical data where possible, we estimate the potential performance against the target levels and correlation between the different incentives performance.
    - Where historical data is unavailable we have developed plausible assumed correlations, with scenario testing to confirm reasonableness.
3. We simulate the incentive-level and overall performance for a notional company in RIIO-GD2 using a Monte Carlo simulation analysis.

Clearly, analysis of this kind requires us to make a wide range of assumptions, in addition to making as much use of historical data as possible. Given the nature of the task we attempt here – essentially to predict the likely distribution of future outperformance – a wide range of supporting assumptions must be made. Having made some set of assumptions, however, this framework allows us to go on to calculate what it would mean for expected outperformance.

We consider that this exercise will bring additional insight and transparency to the process of setting the performance wedge, by providing a proper basis for calculation, even if the inputs are to a degree subjective. In essence, this approach provides a basis for answering the question, “what would one need to believe in order for Ofgem’s proposed 50 bps downward adjustment to headline returns to be valid and reasonable?”.

The reminder of this report is structured as follows:

- section 3 describes the methodology in this study, which includes a detailed description of each incentive modelled as well as an overview of Monte Carlo analysis techniques; and
- section 4 summarizes our findings for the core model as well as for a number of sensitivities ran to test the robustness of results.

3 METHODOLOGY

The objective of this study is to estimate a plausible range for the expected financial outperformance for a notional GDN based on a forensic, bottom up review of price control incentives for GD2. To achieve this we have followed a three-stepped approach for the study

- **Step 1.** Identify the relevant incentives from RIIO-GD2 framework as per Ofgem's methodology document, incorporating insights from NGN on operational aspects.
- **Step 2.** Review detailed information for those incentives which we model to determine modelling parameters. Parameters include:
  - The probability distribution of potential outcomes,
  - The correlation between incentives, and
  - The transformation of incentive mechanism outcomes into financial impacts.
- **Step 3.** Run Monte Carlo simulations to produce probability distributions for financial outperformance wedge:
  - for the 'core' model; and
  - for alternative and sensitivity scenarios, in order to assess how assumptions made may influence the final result.

In this section we describe the approach that we have taken for each of these steps in turn.

For Step 1, we describe the sources of information we have reviewed and the general criteria that we have used to decide which incentives to model. This is followed by a summary table setting out our decisions on which incentives we modelled from our long list.

For Step 2, we provide a description of each incentive modelled, together with information on Ofgem's position and the approach we have taken to determine the necessary parameters for modelling.

Finally for Step 3, we provide a description of the Monte Carlo simulation approach we have adopted.

3.1 Determining which incentives to model

The first step for estimating the outperformance wedge is to identify the incentives that can drive over or under performance in RIIO GD2. To do this we first compiled a long list by reviewing the information published to date by Ofgem on the incentive arrangements it is minded to put in place for GD2. Key documents considered for this exercise include:

- RIIO-2 Sector Specific Methodology Decision and related consultation documents; and
- RIIO-2 Sector Specific Methodology Decision – Gas Distribution and related consultation documents.

A long list of potential incentives were presented within these documents. In order to keep the modelling tractable, while ensuring that it remained sufficiently reflective of the GD2 regulatory framework, we sought to focus on incentives that were material in respect of their likelihood financial impact. Figure 1 below provides a summary of the incentives that were modelled and those that were not. Based on our assessment, we included nine incentives.

Figure 1 Preliminary list of relevant RIIO GD2 incentives[4]

Incentive	Type	Summary of conclusions	Included?
Totex Incentive Mechanism	Totex	This incentive can drive material financial performance, although the scope will be limited by RPE indexation and repex PCD.	Included
Business Plan Incentive	BPI	This incentive can drive material financial performance.	Included
Consumer vulnerability minimum standards	LO	We currently consider that this incentive is primarily reputational and the chances of financial penalties are very low. NGN told us that no supplier has ever faced action against an equivalent license condition.	Not included
Customer satisfaction survey	ODI	Two-sided (penalty and reward) financial ODI retained in GD2	Included
Complaints metric	ODI	One-sided (penalty only) financial ODI retained in GD2	Included
Guaranteed Standards of Performance	LO	Penalty only licence obligation retained in GD2. There have been penalties paid in GD1.	Included
Emergency response time	LO	Penalty only licence obligation retained in GD2. No penalties paid in GD1 but historically there have been.	Included
Average restoration time for total unplanned interruptions	ODI	One-sided (penalty only) financial ODI introduced in GD2 (previously reputational ODI only)	Included
Shrinkage and leakage	ODI	Two-sided (penalty and reward) financial ODI retained in GD2. However, the scope is restricted to changes in shrinkage and leakage due to gas conditioning and pressure management only.	Included
Annual Environmental Report	LO	Based on Ofgem's statements we currently do not expect this to have a financial impact as a notional GDN would produce a compliant report.	Not included
Network Asset Risk Metric	ODI	Effectively downside only penalty applied to underspend on NARMs related totex.	Included

[4] LO stands for licence obligation, ODI stands for output delivery incentive, PCD stands for price control deliverable, and BPI stands for business plan incentives. In addition, NARMs stands for network asset risk metrics, RPE stands for real price effect, totex stands for total expenditure, and repex stands for replacement expenditure.

Uncertainty mechanisms	Other	Modelled as a down side only financial impact because of materiality thresholds. We have taken into account two uncertainty mechanisms, namely RPE and repex volume driver under Totex incentives. Extent of other uncertainty mechanisms in GD2 is currently unclear. Given this uncertainty, we have not modelled any further mechanisms but note this is a conservative approach as it will overstate the range on expected returns.	RPE and repex already included in Totex incentives. No further Uncertainty mechanisms are included.
Return Adjustment mechanisms	Other	Limits the total possible over or under performance. In order to model this it would be necessary to assume a range. Ofgem consulted on +/-300bps but do not propose it as a working assumption. Given uncertainty over the range we have not included this mechanism explicitly in our model. However we note that +/-300 bps is a wider range than the results we see, so had the mechanism been included with a 300 bps range it would have had no impact.	Not included

Source: Frontier Economics and NGN

3.2 Detailed approach for each incentive modelled

The aim of the study is to estimate the expected financial performance for a notional GDN (not for NGN). This means that when considering the parameters for modelling incentives, wherever possible, we have chosen values that reflect the expectations for an average GDN. This applies to all the incentives detailed below.

There will be different views on what the expectations for the target should be as well as outturn performance will be for each of the incentives. We have set a baseline starting point in our core model to reflect a relatively neutral position. More specifically, we have assumed that:

- Ofgem's target for totex would reflect what an average GDN would be able to achieve in outturn;
- For ODI's we have generally assumed that Ofgem will set targets at the upper quartile level, meaning that the average GDN will expect to underperform on these targets
  - We relax this assumption in our alternative model on ODIs (see section 4.1.2)

The overall intention of the calibration is to illustrate possible expectations of performance levels and explore what one needs to assume in order for the average expected outperformance wedge to reach 50 bps.

For some incentives there is insufficient public information available to allow us to form a view on sector performance. Where this is the case we have used data supplied by NGN which reflects their position to inform parameter assumptions. Areas where NGN data has been used to inform at least some of the parameters are:

- RPE and repex volume driver adjustments to totex performance;
- shrinkage and leakage incentive; and

- the RAV to totex ratio for GD2.
  - This is not an assumption for a particular incentive but it is used to transform performance on the outputs included in the model into RoRE terms.
  - A different GDN will have different RAV and Totex values and therefore potentially different results in RoRE terms. Based on a review of RAV/Totex ratios from Ofgem data the spread is relatively low, and we therefore consider that the qualitative results from our analysis remain valid in general.

The rest of this section is structured into subsections. Each subsection describes the approach and parametrisation that we adopted for each incentive in turn. The Correlation matrix for the modelling is dealt with in the final subsection as is related to all of the incentives.

3.2.1 Totex

In modelling the financial impact of variations in totex outperformance we also take into account RPEs and PCDs. The former relates to the mechanism to account for the input price inflation being different from the general consumer price inflation used in the price control, and the latter refers to specific commitments given during the price control that will either be delivered (or not) and this will be assessed at the end of the price control or at the end of each year. This is relevant to repex.

We account for RPEs because changes to how RPEs are applied for GD2 will limit the range of possible totex performance. We account for PCDs because we understand that their intended effect is to restrict any totex outperformance as a result of changes to the outputs delivered by GDNs (i.e. outperformance through non-delivery can be expected to be clawed back).

We capture the effects of RPEs and PCDs through adjustments that we make to our totex modelling.

What has Ofgem said?[5]

Totex Incentive Rate

Ofgem has said that the Totex incentive mechanism would apply a confidence-dependent incentive rate.

Ofgem's current working assumption is that it will assign high-confidence baseline costs with a 50% incentive rate and other costs with a 15% incentive rate. A single incentive rate will be calculated based on the balance of high-confidence and lower-confidence baseline costs included in final totex allowances.

RPEs

Ofgem will set price control allowances which can include an adjustment for the difference between general inflation and the input price changes experienced on the specific inputs that are used by gas distributors (RPEs). In RIIO-1, Ofgem set fixed assumptions to adjust allowances over the eight year price controls, resulting

[5] https://www.ofgem.gov.uk/system/files/docs/2019/05/riio-2_sector_specific_methodology_decision_-_core_30.5.19.pdf. Chapter 11

in Ofgem providing upfront allowances for RPEs based on its expectations at the time.

In the RIIO-2 Framework Decision, Ofgem stated that it would index uncertain costs where possible, including for labour and construction cost inflation (to the extent evidence suggests that input prices are different from general consumer price inflation).

PCD (Repex volume driver)[6]

Ofgem is proposing to put in place output targets for the total volume (in kilometres) of Tier 1 iron mains abandoned over the RIIO-GD2 period. This output would be a PCD. Under this PCD, cost allowances will be adjusted ex post for any undelivered workloads relative to the RIIO-GD2 target. Any over delivery will not be subject to additional funding under the PCD mechanism.

Our Approach

Probability distribution

We assume that the notional GDN's totex performance is normally distributed with mean zero and a standard deviation informed by historical data.

By assuming that the mean of the distribution is at zero we are assuming that Ofgem sets Totex allowances that a notional company can meet but not beat, on average. In this case, Ofgem would not expect the average GDN to out- or under-perform against its Totex allowance.

We acknowledge that past performance may indicate that some degree of average outperformance on totex might be considered central, rather locating the performance distribution around a central value of zero. However, we note that:

- it will certainly be Ofgem's intent to set allowances that do not systematically provide expected reward for companies, hence our assumption is consistent with assuming that Ofgem is successful in achieving this intent;
- if Ofgem sets totex allowances based on an upper quartile benchmarking methodology then assuming zero mean outperformance is consistent with GDNs improving their efficiency to meet targets that current performance suggests is presently beyond their average capability; and
- by adopting an initial assumption of zero outperformance on totex, we are able to create a baseline from which the rest of our modelling can run.

We relax this assumption later on in our analysis.

The assumed standard deviation of totex performance is based on the observed standard deviation of actual annual totex performance for each licensee in GD1. This is then adjusted to account for the impact of RPEs.

We assume that Ofgem will apply indexed RPEs in GD2 rather than the ex-ante allowances provided in GD1. This will narrow the range of possible totex performance against allowances as variance in performance due to RPEs will now be removed. To inform the assumption about the impact of indexing RPEs we

[6] https://www.ofgem.gov.uk/system/files/docs/2019/05/riio-2_sector_specific_methodology_decision_-_gd.pdf

compared the totex performance of NGN in RIIO GD1 to the calculated value of RPE outperformance that Ofgem requested NGN to return.[7] The percentage of outperformance that Ofgem ascribe to RPEs was used to scale down the variation in future performance.

Ofgem has indicated that it is still considering whether to apply RPEs at all. Our analysis assumes that it does so. If however this proves to be incorrect, then we would need to revisit our analysis to:

- extend out the standard deviation of potential totex outperformance; and
- consider whether and by how much to shift the average of the distribution of outperformance. Our *a priori* view is that a failure to allow RPEs would lead to an, all other things equal, expectation of underperformance driven by the expectation that there will be positive real wage growth over time.

We also apply an adjustment for the introduction of repex volume drivers which introduces an asymmetry to the financial impact of totex performance. Similar to RPEs, at RIIO GD1 Ofgem calculated an amount of outperformance that NGN had achieved through repex underspend that Ofgem considered that NGN should return.[8] We compare this to NGN's RIIO 1 totex outperformance and use it to scale down the **range** of potential totex financial out-performance whilst leaving under-performance unchanged (i.e. leaving the **location** of the slightly moderated range of performance unchanged).

Financial impact

In order to estimate the final financial impact of totex over or under performance we must define a totex sharing rate. Ofgem has indicated that it will apply a blended sharing rate of 15-50% based on the relative share of high and low confidence costs. We have assumed that 50% of costs are high confidence and 50% low confidence. This gives us a symmetric sharing rate of 32.5%.

3.2.2 Business Plan Incentive

The business plan incentive is intended to encourage GDNs to submit high quality and ambitious business plans. The incentive is two sided with the potential for outperformance and underperformance capped at +/- 2% of totex allowances. The incentive will operate in four stages:

- **Stage 1**: Minimum requirements.
  - A fixed penalty of 0.5% of totex for plans that fail to meet Ofgem's minimum requirements.
- **Stage 2**: Consumer value proposition.
  - A reward based on consumer value proposition.
  - Limited to deliverables not otherwise funded in the business plan.

[7] We note that NGN did not consider this calculation to be justified and did not make a voluntary contribution but we consider it to be indicative of Ofgem's views and therefore the impact Ofgem's approach may have in GD2.

[8] We note that NGN did not consider this calculation to be justified and did not make a voluntary contribution but we consider it to be indicative of Ofgem's views and therefore the impact Ofgem's approach may have in GD2

- Full methodology not yet determined.
- **Stage 3:** penalty for poorly justified costs.
  - 10% penalty on the value of poorly justified costs that Ofgem removes from GDN's forecasts through the cost assessment process.
  - Only applies to lower-confidence baseline costs.
- **Stage 4**: upfront reward for companies that submit forecasts below Ofgem's independent baseline.
  - Based on the difference between the independent baseline and the company's forecast.
  - The incentive rate will be equal to the totex incentive rate for the company.

What has Ofgem said

Ofgem has set out the four-stage nature of the business plan incentive. It has not yet fully defined how all aspects of the incentive will work. They have also yet to give an indication of what it would expect the mean impact of the incentive would be on GNDs. Based on Ofgem's documents it is unknown if Ofgem expects that on average the BPI will be set at zero expected value or whether they would expect that it would generally be more likely to provide GDNs with upside or downside.

Our Approach

The four-stage structure of the BPI is complex and some aspects of how stage 2 will operate have yet to be fully defined by Ofgem. The incentive in this form is also new for GD2 meaning that we do not have comparable historic data on performance against this incentive.

Given these factors, for our core model, we have adopted a parsimonious approach for the purposes of modelling the impact of the BPI. We model the incentive as a single stage mechanism that can deliver over or under performance of between +/- 2% of totex. This requires the fewest assumptions to broadly capture the potential impact of the BPI. In the absence of an indication from Ofgem, for the core model, we assume that the BPI is set up as a 'fair bet' with the most likely outcome being no impact and the more extreme positive or negative impacts being less likely than more moderate impacts.

We recognise that the approach for the core model is a simplification and that the 'fair bet' assumption is important but based on limited evidence. Therefore, we also conduct two sensitivities. One which reflects a greater chance of GDNs failing stage 1 of the business plan (e.g. due to not accepting the Ofgem WACC) and one that models the BPI in four stages with the additional assumptions necessary to do so. See Sections 4.2.2 for details of these.

3.2.3 Customer Satisfaction Survey

The Customer Satisfaction Survey (CSS) was introduced to incentivise GDNs to improve the quality of their customer service. The survey targets three groups of customers: (i) those that have experienced a planned interruption or replacement

work; (ii) those that have experienced an unplanned interruption; and (iii) those requiring connections works. In RIIO GD1, the CSS incentive was set up as a two-sided financial ODI, whereby companies exceeding the target were rewarded and company below the target penalised.

What has Ofgem said?[9]

As part of the RIIO-2 GD methodology, Ofgem has confirmed that a satisfaction survey will be retained for the gas distribution sector. In the December consultations, Ofgem considered whether to set a static target (as in GD1) or introduce a dynamic target instead (i.e. a target set at the beginning of the price control but updated annually to reflect improvements in the industry). At this stage, it is still unclear whether Ofgem will opt for a static or dynamic target for the CSS. The target will however be common to all GDNs.

Ofgem is currently considering two alternative incentive designs. Under the first option, Ofgem will retain the current mechanism where rewards and penalties are available up to 0.5% of base revenues, depending on performance against the target score. The second option is instead a "penalty and pot" approach, where only companies exceeding a particular score (e.g. 9/10) are rewarded and companies are penalised for scoring below the target.

Our Approach

Financial impact

Ofgem has recognised that the incentive scheme has worked well throughout RIIO GD1. On this basis, we have assumed that the financial reward and penalty for GDNs will be calculated in line with the current design.

For the purpose of this study, we have assumed a static target applicable to all GDNs. In line with the GD1 methodology,[10] we have assumed a separate target for each customer category (unplanned interruptions, planned interruptions and connections). We have estimated the target and maximum reward/penalty scores based on historical actual GD1 CSS scores, for all GDNs and covering the regulatory years 2013/14 to 2018/19.

In line with the GD1 methodology, we have assumed a target score equal to the upper quartile score. Maximum reward and penalty scores were instead calculated as the simple average of 1.5 and 1.75 SD from the mean score.[11] Figure 2 below summarizes the scores assumed in the Monte Carlo simulation.

[9] Ofgem RIIO-2 Sector Specific methodology Decision – Gas Distribution, 24 May 2019. https://www.ofgem.gov.uk/system/files/docs/2019/05/riio-2_sector_specific_methodology_decision_-_gd.pdf

[10] RIIO-GD1: Final Proposals - Supporting Document – Outputs, incentives and innovation, 17 December 2012. https://www.ofgem.gov.uk/ofgem-publications/48155/2riiogd1fpoutputsincentivesdec12.pdf

[11] This is in line with the methodology followed by Ofgem in RIIO GD1, which relied on a simple approach based on 1.5-1.75 standard deviations from the mean score. See RIIO-GD1: Final Proposals - Supporting Document – Outputs, incentives and innovation, 17 December 2012, page 20.

Figure 2 Assumed target scores CSS

Assumed score	Planned Interruptions	Unplanned Interruptions	Connection
Target	8.73 (8.09 in RIIO GD1)	9.45 (8.81 in RIIO GD1)	9.01 (8.04 in RIIO GD1)
Max reward	9.06 (8.50 in RIIO GD1)	9.60 (9.00 in RIIO GD1)	9.53 (8.40 in RIIO GD1)
Max penalty	7.68 (7.50 in RIIO GD1)	9.02 (8.00 in RIIO GD1)	7.20 (7.30 in RIIO GD1)

Source: Frontier Economics based on data from the following sources: RIIO-GD1 Annual Reports supplementary data file and GDN's Regulatory Reporting Pack

Probability distribution of outcomes

For each score category, we have assumed a normal distribution of outcomes. Mean and standard deviation scores have been calculated based on GD1 outturn data for all GDNs, covering the regulatory years 2013/14 to 2018/19 – these are summarized in Figure 3.

Figure 3 Normal distribution parameters

	Planned Interruptions	Unplanned Interruptions	Connection
Mean	8.37	9.31	8.37
Standard deviation	0.42	0.18	0.72

Source: Frontier Economics based on data from the following sources: RIIO-GD1 Annual Reports supplementary data file and GDN's Regulatory Reporting Pack

We also consider an alternative specification, in which the mean is increased to the level of the upper quartile from GD1 such that the target and mean performance are equal. This assumes that GDNs can on average achieve GD1 upper quartile performance. For more detail, see Section 4.1.2.

3.2.4 Complaints metric

The complaints metric incentive is intended to drive GDNs to improve their handling of customer complaints. It is a penalty-only financial ODI. In GD1, Ofgem set out that complaints metric should be assessed against four indicators (relative weight in brackets): (i) percentage of complaints unresolved after one working day (10%); (ii) percentage of complaints unresolved after 31 working days (30%); (iii) percentage of repeat complaints (50%); (iv) percentage of Energy Ombudsman (EO) findings against the GDN (10%). We understand that the calculation of this metric will not change in RIIO GD2.

What has Ofgem said?[12]

Ofgem has confirmed that it will set a static target under this incentive, common to all GDNs. The new target level however is expected to be set at a more challenging level, to reflect the improved performance of GDNs over GD1.

[12] Ofgem RIIO-2 Sector Specific methodology Decision – Gas Distribution, 24 May 2019. https://www.ofgem.gov.uk/system/files/docs/2019/05/riio-2_sector_specific_methodology_decision_-_gd.pdf

Ofgem has confirmed that it will retain this incentive as penalty-only and is not proposing to change the underlying financial penalty calculations. Ofgem has signalled that the incentive strength will be similar to GD1 and may be worth up to 0.5% of base revenues, however this is still under consultation.

Our approach

Financial impact

In line with Ofgem current view, we have calculated the monetary impact of under-performing versus the target in line with the current GD1 framework. We have estimated penalties to be worth up to 0.5% of base revenues, depending on performance against the target score.

We have inferred the new (more challenging) target and maximum penalty scores based on historical GD1 complaints metric actual scores. The sample includes outturn scores for all GDNs and covers the regulatory years 2013/14 to 2018/19.

In line with the GD1 methodology,[13] we set the target score based on the upper quartile score; the maximum penalty score is calculated as 1.75 standard deviations from the historical average.[14] These are summarized in Figure 4 below.

Figure 4 Assumed target scores complaint metrics

Assumed score	Complaint metrics
Target	9.80 (11.57 in RIIO GD1)
Max penalty	12.47 (23.23 in RIIO GD1)

Source: Frontier Economics based on data from the following sources: RIIO-GD1 Annual Report 2017-18 supplementary data file and GDN's Regulatory Reporting Pack

Probability distribution of outcomes

We have assumed a normal distribution of outcomes for the complaint metrics incentive. Mean and standard deviation scores for the 'core' model have been calculated based on GD1 outturn data for all GDNs, covering the regulatory years 2013/14 to 2018/19 – these are summarized in Figure 5.

Figure 5 Normal distribution parameters

	Complaint metrics
Mean	6.50
Standard deviation	3.41

Source: Frontier Economics based on data from the following sources: RIIO-GD1 Annual Report 2017-18 supplementary data file and GDN's Regulatory Reporting Pack

We also consider an alternative specification, in which the mean of the distribution is increased to the level of the upper quartile from GD1 such that the target and mean performance are equal. See Section 4.1.2.

[13] RIIO-GD1: Final Proposals - Supporting Document – Outputs, incentives and innovation, 17 December 2012. https://www.ofgem.gov.uk/ofgem-publications/48155/2riiogd1fpoutputsincentivesdec12.pdf

[14] This is in line with Ofgem's approach at RIIO GD1. While for the CSS metric Ofgem calculated the maximum penalty score based on 1.5-1.75 standard deviations from the mean level of performance, for the complaints metric this was calculated based on 1.75 standard deviations from the mean. For each metric, we have retained Ofgem RIIO GD1 approach in this study, which explains the differences across the two.

3.2.5 Guaranteed standards of performance (GSOP)

Guaranteed standards of performance were introduced to provide financial incentives for the GDNs to ensure that they aim to achieve a set of common minimum performance standards with respect to interruptions, connections and customer service.

What has Ofgem said?

Ofgem has confirmed retention of the current GSOP licence obligation. Where evidence suggests that current standards are outdated, Ofgem foresees tightening the target levels.

Our Approach

There are 14 GSOP in total.[15] On average, the total payment that GDNs have had to pay in the first five years of GD1 (2013/14 – 2018/19) was less than £450k.

Given the relatively low aggregate financial penalty associated with this incentive, we have considered all the GSOP taken together as a single incentive rather than modelling each of the standards separately. We model GSOP as a direct financial impact rather than modelling performance against the 14 different standards and then converting this into a financial performance. We assume that the average GSOP impact is as per the current GD1 data and is normally distributed with a standard deviation based on the same data.[16,17] We note that this is a conservative approach for two reasons:

- Ofgem has announced that some standards will tighten which might be expected to increase the average penalties for missing GSOP; and
- Some GDNs are already voluntarily paying greater penalties for missing GSOP.

We do not take account of either of these factors in our modelling. All else equal this will mean that our modelling marginally over estimates the expected financial performance.

3.2.6 Emergency Response Times

This incentive ensures that GDNs respond to 97% of reported gas escapes within one hour for uncontrolled escapes and two hours for controlled escapes.

[15] Ofgem RIIO-2 Sector Specific methodology Decision – Gas Distribution, 24 May 2019, Table 3. https://www.ofgem.gov.uk/system/files/docs/2019/05/riio-2_sector_specific_methodology_decision_-_gd.pdf

[16] In the model, we have normalised the historical financial performance of GDNs by the total number of customers connected to the network in order to control for any difference in size of GDNs' the customer bases.

[17] We note that this is a conservative approach. Ofgem has announced that some of the standards are likely to be tightened. By not addressing each of them in turn, but instead considering the financial impact of GSOP penalties in the round, we have de facto assumed that expected performance is higher than actual (or in other words, that the expected financial penalty will be lower than actuals).

What has Ofgem said?[18]

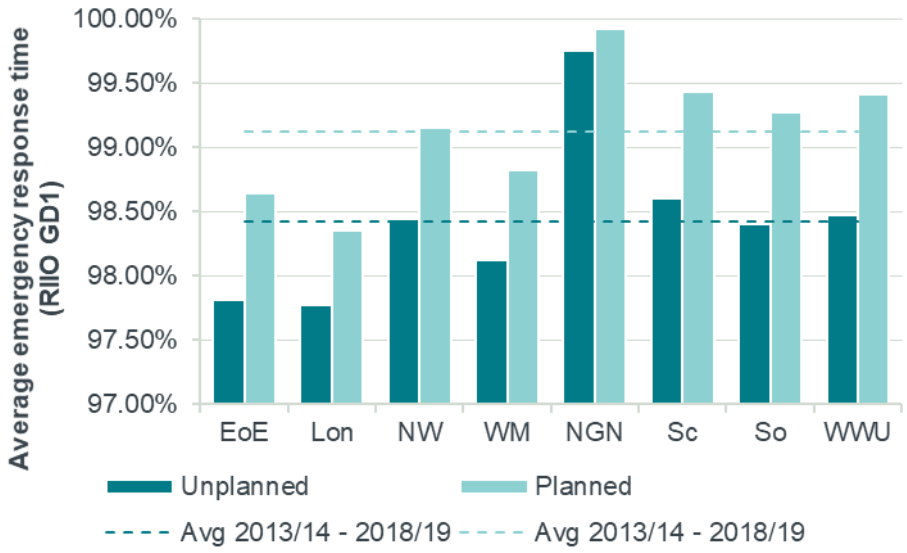
This is a licence obligation which will be retained in RIIO GD2 with an unchanged performance standard.

Our approach

Ofgem has proposed to retain the long-standing output and performance target of 97% for GD2.

As shown in Figure 6 below, the 97% standard for responding to reported gas escapes within one hour for uncontrolled escapes and two hours for controlled escapes has always been met or exceeded in GD1.

Figure 6 Average emergency response time by GDNs in GD1 (including regulatory years 2013/14 to 2018/19)



Source: Frontier Economics based on data from the following sources: RIIO-GD1 Annual Report 2017-18 supplementary data file and GDN's Regulatory Reporting Pack

Whilst we observe from recent data that no licensee has failed the standard in recent years we understand from NGN that this may have been helped by benign weather conditions.

Historical performance however shows instances of GDNs being fined for failing this LO. For example, in 2010/11 NGN was fined £900k for not meeting the 97% standard.[19] More recently, Cadent was fined more than £40 million for MOBs record-keeping without formally failing any regulatory standards.[20] On this basis, a notional GDN could face a significant fine if it were to fail to meet the emergency response standard. Therefore, we have modelled performance for this incentive on a scenario basis and assigned a probability to the scenario being realised.

[18] Ofgem RIIO-2 Sector Specific methodology Decision – Gas Distribution, 24 May 2019. https://www.ofgem.gov.uk/system/files/docs/2019/05/riio-2_sector_specific_methodology_decision_-_gd.pdf

[19] https://www.ofgem.gov.uk/ofgem-publications/37591/ngn-penalty-decision-final-pub-pdf

[20] https://www.ofgem.gov.uk/publications-and-updates/cadent-pays-24-million-past-failures-and-establishes-20-million-community-fund

Following discussions with NGN about a reasonable scenario to model we have defined emergency response time performance based on:

- £10m fine if the standard is missed
- 1 in 20 chance of scenario being realised
  - This is based on the gas network being secured against a 1 in 20 winter standard.

We have tested the robustness of our assumptions around this incentive and have run a sensitivity that excludes the financial impact of this incentive – see Section 4.2.1.

3.2.7 Average restoration time for unplanned outages

The average restoration time for unplanned outages incentive incentivises GDNs to prevent any significant deterioration in the length of unplanned interruptions. In RIIO GD2 Ofgem will introduce a penalty-only financial ODI – this will cover all unplanned interruptions with the exception of those on Cadent's North London Network.[21]

What has Ofgem said?[22]

In GD1, performance was measured as total minutes lost across all interruptions during the year and the ODI was reputational only. For RIIO GD2. Ofgem has proposed converting this incentive into a penalty-only financial ODI.

Ofgem has decided that GDNs will be required to propose and justify their own specific targets for the average restoration time in their Business Plan.

Ofgem has proposed a financial incentive worth up to 0.5% of base revenues per annum, with the penalty increasing as performance against the target level deteriorates. Some Stakeholder have considered a penalty worth up to 0.5% of revenues excessive and this will be subject to further consultations.

Our approach

Financial impact

In line with Ofgem's latest position on this, we have assumed a maximum penalty equal to 0.5% of revenues. This has been assumed to increase linearly as performance worsen compared to the target level.

As discussed above, this is a company driven target. On this basis, we have considered for the Monte Carlo simulation a target suggested by NGN of less than 10 hours. This is in line with the median performance of all GDNs during RIIO GD1, excluding Cadent London, in line with Ofgem's suggestion.[23]

[21] For Cadent's North London network, Ofgem is planning to introduce a penalty-only ODI that relates to MOB interruptions and a separate penalty-only ODI that relates to other interruptions. The former are out of the scope of this report.

[22] Ofgem RIIO-2 Sector Specific methodology Decision – Gas Distribution, 24 May 2019. https://www.ofgem.gov.uk/system/files/docs/2019/05/riio-2_sector_specific_methodology_decision_-_gd.pdf

[23] The median performance of all GDNs in RIIO GD1 (2013/14 to 2018/19) is 13 hours. As discussed above, the historical average restoration time for unplanned interruptions for Cadent London is substantially higher

Ofgem have not decided exactly how the penalty will be calculated. The complaints metric incentive shares some similarities with this incentive. Both are penalty only with the penalty increasing as performance against a target level decreases. Both the complaints metric and the consumer satisfaction survey are worth up to 0.5% of revenues. Therefore, we have assumed that the incentive will calculate the penalty in a similar way as it is for these incentives.

We have calculated the maximum penalty score as 1.625[24] standard deviations above historical average performance of all GDNs (excluding Cadent London) between 2013/14 and 2018/19. We assume that the penalty increases linearly between the target and the max penalty score. The assumed target score and maximum penalty score are summarized in Figure 7 below.

Figure 7 Assumed target scores average restoration time for unplanned outages

Assumed score	Avg restoration time unplanned outages
Target	10 hours
Max penalty	21.27 hours

Source: Frontier Economics based on data from GDN's Regulatory Reporting Pack

Probability distribution of outcomes

We have assumed a normal distribution of outcomes for the average restoration time for unplanned outages incentive. Mean and standard deviation scores have been calculated based on RIIO GD1 outturn data for all GDNs, covering the regulatory years 2013/14 to 2018/19 – these exclude historical data for Cadent London (as discussed above) and are summarized in Figure 8.

Figure 8 Normal distribution parameters

	Avg restoration time for unplanned outages
Mean	12.87 hours
Standard deviation	5.17

Source: Frontier Economics based on data from GDN's Regulatory Reporting Pack

3.2.8 Shrinkage and Leakage

The incentive exposes GDN's to the market and social cost of the gas escapes from their networks. The mechanism is two sided and provides the incentive for GDNs to take actions to reduce the volume of gas that escapes from their networks.

than other GDNs – this is due to concentration of MOBs in North London. Ofgem will set a different target for Cadent London to account for this.

[24] As noted in footnotes 11 and 14,in RIIO GD1 Ofgem set the maximum penalty score for complaints metric based on 1.75 standard deviations from the mean performance score, whilst setting the maximum penalty score for consumer satisfaction survey based on 1.5-1.75 standard deviations. from the mean. There is no information available to date on how Ofgem envisions setting the maximum penalty score for the average restoration time for unplanned outages. We have assumed this to be calculated as 1.625 standard deviations from the mean performance score, i.e. the simple average between 1.5 and 1.75.

What has Ofgem said?[25]

The financial incentives around shrinkage and leakage will change for RIIO-GD2. In GD1 the volumes used for the calculation of the incentive were based on total movements in shrinkage and leakage. In RIIO GD2, the impacts on shrinkage and leakage which are driven by the repex programme will be excluded from the calculation volume.

The RIIO-GD2 shrinkage incentive will be based on the specific impact (in GWh volumes) of pressure management and gas conditioning, in comparison to what would have been recorded if average pressure and MEG had remained at the same levels as in the final year of RIIO-GD1.

Ofgem is considering whether a cap and collar on the incentive would be appropriate and will consult further at Draft Determination.

The calculation of financial impacts will continue to be based on gas prices and carbon values as per GD1.

Our Approach

Financial impact

Ofgem has made it clear that the static target will be to maintain performance attributable to pressure management and gas conditioning at the position GDNs achieve at the end of GD1.

The calculation of the financial impact is based on applying BEIS forecasts of gas and carbon prices to the changes in shrinkage and leakage volumes.

Ofgem has indicated that it is considering a cap and collar mechanism for the incentive. However, it is not clear whether this will be implemented or, if it were, at what levels the cap or collar would be set. Therefore, at this stage we have not implemented a cap or collar in the modelling of financial impacts.

Probability distribution of outcomes

In the absence of other evidence, we assume that the potential outcomes are normally distributed. We assume that the mean performance of a notional GDN sees no change in shrinkage or leakage attributable to gas conditioning and pressure management versus the last year of GD1. This effectively assumes that the target is a “fair bet” with companies as likely to underperform as outperform.

In making this assumption we note that Ofgem has not been clear about how it will treat changes in pressure that are driven by the repex programme. In some cases the repex programme will lead to increases in system pressures (e.g. when GDNs use insertion techniques). If these effects are not appropriately captured in the assessment of the shrinkage and leakage volumes this may make underperformance more likely on average.

To estimate the standard deviation, we have used data from NGN on the impact that pressure management alone has had on their shrinkage volumes and assumed that leakage is fixed at 95% of shrinkage. We recognise that this

[25] https://www.ofgem.gov.uk/system/files/docs/2019/05/riio-2_sector_specific_methodology_decision_-_gd.pdf

evidence is limited as we have only had data on this for NGN and not for all GDNs. This is because whilst there is information on the shrinkage and leakage figures for all GDNs in GD1 this data does not isolate the impact of pressure management so is not informative for the likely spread of outcomes for the revised incentive mechanism in GD2.

3.2.9 NARMs[26]

The network asset risk metrics incentive is intended to ensure that GDNs maintain assets in good condition using the price control funding provided for this purpose. It works by setting a target in terms of the network risk metric. If this target is missed a penalty rate is applied to the cost it would take to bring the measured network asset risk to the target level.

What has Ofgem said?

The NARM mechanisms will apply only to the asset categories within scope of the current network output measure (NOMs) mechanisms.

Asset management works that are out of scope of the NARM will be subject to separate assessment, funding and output arrangements, depending on their drivers and deliverables.

For over-delivery, the default position will be that the cost of over-delivery will be subject to the totex incentive mechanism. However, at the end of RIIO-2, a company may make a case to Ofgem for being held cost neutral for a certain part of the over-delivery on an exceptional basis. Where, having considered the case put forward by the company and any other relevant information, Ofgem deems any portion of the over-delivery to be justified, then the company will be made cost neutral for the relevant additional costs it has incurred for that portion of the over-delivery. The cost of over-delivery in this circumstance will be taken to be Ofgem's view of the efficient cost of such over-delivery.

For under-delivery, the default position will be that Ofgem will claw back any allowances associated with the under-delivery plus it will impose a penalty which is an amount proportionate to this clawed back amount (with the proportion to be further developed as part of the Draft and Final Determinations). However, at the end of RIIO-2, a company may make a case to Ofgem that some or all of the under-delivery was justified.

Where, having considered the case put forward by the company and any other relevant information, Ofgem deems any portion of the under-delivery to be justified, then it may choose not to apply the penalty associated with that portion of the under-delivery.

The current penalty rate for NOMs in RIIO1 is 2.5% of the associated cost of under-delivery.[27]

[26] Chapter 6 https://www.ofgem.gov.uk/system/files/docs/2019/05/riio-2_sector_specific_methodology_decision_-_core_30.5.19.pdf

[27] https://www.ofgem.gov.uk/system/files/docs/2018/12/network_output_measures_noms_incentive_methodology_-_change_tracked_0.pdf

Our Approach

We model the impact of the NARMs incentive based on the difference between performance and target rather than performance directly. Therefore, we do not need to define a target performance for the notional GDN.

We did not find any publicly available information that gave insight into the probability that a notional GDN would under deliver against their NARMs targets, indeed we consider that such evidence may not exist as the prevailing NARMs methodology was only introduced for the current set of, as yet incomplete, price controls.

In addition, Ofgem have stated that if companies do miss their NARMs targets they can make a case to Ofgem that this was justified. If Ofgem considers that any underperformance was justified there would be no penalty. Given this position we have modelled performance on a scenario basis and assigned a probability to the scenario being realised.

Following discussions with NGN about a reasonable scenario to model we have defined NARMs performance based on:

- 10% underspend on NARMs related totex
  - Approximated as 80% of (capex + repex)
- 1 in 8 chance of scenario being realised (i.e. an expectation that one of the 8 licensees incurs a penalty at each price control).

Ofgem's position is that under-delivery will be subject to a penalty rate and that for over delivery companies may be able to apply to be made cost neutral. Therefore, we have modelled this incentive as downside only. We have assumed that the current NOMs penalty rate of 2.5% will apply to the cost of any under delivery.

3.2.10 Summary of core model input distributions

A summary of the core model's input distributions is presented in Figure 9 below. The majority of incentives are modelled as non-skewed normal distributions. The Business Plan Incentive is modelled as a bounded triangular distribution to account for Ofgem's cap of ±2% of totex which can be levied as a penalty or reward. The Emergency Response Time and Network Asset Risk Metric incentives are modelled as Bernoulli distributions to model the binary nature of whether a notional company will fail to meet either target.

Figure 9 Core model specification

Measure	Unit of measure	Distribution	Target	Normal distribution parameters		Triangular distribution parameters			Bernoulli distribution parameters
				Mean	SD	Min	Mode	Max	Probability of event
Totex outperformance	%	Normal	0.0%	0.0%	3.1%				
Business Plan Incentive	% of totex	Triangular	0			-2.0%	0.0%	2.0%	
Planned Interruption	Numerical score	Normal	8.7	8.37	0.42				
Emergency Response and Repair	Numerical score	Normal	9.4	9.31	0.18				
Connection	Numerical score	Normal	9.0	8.37	0.72				
Complaints metric	Numerical score	Normal	9.8	6.50	3.41				
GSOP	£ per connected customer	Normal		0.17	0.20				
Emergency response time	N/A	Bernoulli							5%
Loss of supply	Hours	Normal	10.0	12.87	5.17				
Shrinkage and leakage	GWh	Normal	0.0	0.00	4.76				
Network Asset Risk Metric (NARM)	N/A	Bernoulli							12.5%

Source: *Frontier analysis and judgements*

Note: *For more details on the unit of measures, see Figure 48*

3.2.11 Correlation between incentives

Performance on a number of different incentives will be correlated. For example, one might expect a negative correlation between customer satisfaction and emergency response time (i.e. fewer incidents attended to beyond the target response time the more satisfied customers are likely to be) to be reflected in outturn performance data.

In a Monte Carlo analysis it is necessary to account for correlations between different random variables in order to ensure that the final distribution of overall performance is as accurately represented as possible.[28] Part of the Monte Carlo simulation therefore involved specifying correlation coefficients between all incentives in a correlation matrix.[29]

[28] In our analysis correlation primarily impacts the range of outcomes that are observed and has relatively limited impact on the estimate of average performance.

[29] If two outputs are perfectly correlated the correlation coefficient will be 1 and the outperformance of the two would be additive. If both incentives have a range of +-1% RoRE in equivalent out/underperformance, then the two of them together would result in +-2% RoRE out/under-performance.

If there is no correlation between them the correlation coefficient will be 0, and the net result of the two would not be additive. Again, if both incentives have a range of +-1% RoRE, the two of them together will not result in a range of +-2%, but rather a number smaller than that.

Where possible, we calculated correlations between incentives using historical data. Each data series is constructed using actual scores of all GDNs during the regulatory years 2013/14 to 2018/19. This is with the exception of emergency response time, for which data from Cadent London have been excluded from the sample.[30]

Where historical data was not available, we have assumed correlations based on the logical workings of each incentive and industry knowledge. This is the case for the BPI, shrinkage and leakage incentive, NARMs and totex.

Figure 10 below summarizes the correlations utilised in our core model. We have further tested the robustness of our results by testing whether these are sensitive to changes to the correlation matrix – see Section 4.2.3.

Figure 10 Correlation matrix (core model)

	Totex outperformance	BPI	Plan int.	Emerg. resp. & rep.	Conn.	Comp metric	GSOP	Emergency resp. time	Avg rest. time	S&L	NARMs
Totex outperformance											
BPI											
Planned int.	-										
Emergency response & repair	-		+								
Connections	-		+	+							
Complaints metric	-		+	+	+						
GSOP			+	+	+	+					
Emergency response time	-		+	+	+	+	+				
Avg. restoration time for unplanned int.	-		+	+	+	+	+	+			
Shrinkage & leakage											
NARMs	-										

Source: Frontier Economics analysis, RIIO-GD1 outturn data

Note: Red = derived from data, Teal = assumed value (we test sensitivity to this)

If two outputs are perfectly negatively correlated, then the net outperformance will be exactly offset, even though individually the two incentives might both have high potential for outperformance. Again with both incentives having +-1%, this pair would result in a net range of 0%.

[30] Cadent data on emergency response times is an outlier due to the greater prevalence of multiple occupancy buildings (MOBs)

To help understand this table, take row “emergency response & repair” and column “planned int”. The “+” sign shows that the financial outcome of these two incentives are positively correlated, in that when the company under-performs on one of the two incentives, it also tends to underperform on the other one (equivalently, outperformance on one should lead to outperformance on the other). This is logical, as the two performance metrics tend to point to a common underlying cause.

In contrast, take row “Complaints metric” and column “Totex”, the “-“ sign shows that when a company out-performs on totex, it tends to under-perform on complaints metric due to the decrease in spending on services that would prevent complaints.

Due to the way the various incentive metrics are measured, the actual correlation coefficient does not necessarily follow the same signs (e.g. for some metrics an increase reflects out-performance while for others it reflects under-performance). We show the exact correction coefficients used in our modelling in ANNEX B.

In respect of this table we note that:

- Totex correlations are based on logical judgements and were classified as positive or negative and large or small.
  - The large and small assumptions are based on our subjective judgement. We have also modelled sensitivity scenarios in which these correlations are doubled and halved to check if the results are sensitive to these changes.
- All pairwise correlations with the emergency response time incentive are calculated based on outturn GDN scores for this incentive during the regulatory years 2013/14 to 2018/19.[31]
  - We calculate this correlation based on the outturn underlying data. However, as described in section 3.2.6, we model the financial impact of incentive as a binary variable (i.e. with a probability of 5% per annum the notional GDN incurs a given financial penalty, and with a probability of 95% it doesn’t). We consider the correlation of the underlying data to still be informative of the interaction between the emergency response time and other incentives.
- In line with our approach to modelling the GSOP incentive, the correlations between this input and all other incentives are based on historical data on the financial performance of GDNs with respect to GSOP. This is as opposed to modelling each GSOP separately.

3.3 Monte Carlo simulation

Monte Carlo simulations are used to model the probability of different outcomes in a process that cannot easily be predicted due to the existence of random variables inputs.[32] They involve running a large number of simulations based on a specific

[31] There are actually two measures of emergency response times. Response within 1 hr and response within 2hr. However, these two measures are strongly correlated with each other. Therefore, for simplicity we only use the correlation with the 2hr standard in the modelling.

[32] https://www.investopedia.com/terms/m/montecarlosimulation.asp

mean, probability distribution and correlations of uncertain inputs. The result is a probability distribution of the output value, with the Monte Carlo simulation aggregating outputs from all the iterations to calculate the output distribution.

In this study, we have used a Monte Carlo simulation to estimate the probability distribution of the net overall outperformance or underperformance of the RIIO GD2 financial incentives. This simulates the impact on performance of all incentives simultaneously, taking into account the correlation between them.

For each of the nine incentives set out in the previous sub-section, the following inputs are needed in order to run a Monte Carlo simulation on performance:

- the expected allowance (i.e. the incentive target);
- the probability distribution;
- the extent to which the different incentives interact with one another, i.e. the correlation matrix between the incentives.

Section 3.2 above describes in turn for each incentive assumptions on the target level and the distribution of outcomes. Section 3.2.10 sets out our assumptions around the correlations between each pair of incentives. Where possible, the target, performance probability distribution and correlations were based on outturn historical data for all GDNs. Where no historic data was available, assumptions were made on in-principle logics.

4 RESULTS AND INTERPRETATION

4.1 Key findings

We have not identified a reasonable basis on which an average GDN can be expected to outperform by 50 bps in RoRE terms during GD2. Our Monte Carlo simulation in the core model suggests:

- the average GDN is expected to underperform by some 27 bps in RoRE terms. This result reflects our assumptions in the base case that:
  - there is zero expected totex outperformance;
  - that the average GDN – almost as a matter of definition – will fail to meet targets set by Ofgem on the basis of expected upper quartile performance; and
  - that Business Plan Incentives will be set with zero expected value (i.e. companies do not anticipate a loss on average).
- the probability of an average GDN achieving the 50 bps in our base case is 2.6%.
- In order for 50 bps to be a valid central assumption in our base case, it would be necessary for Ofgem to believe that in expectation the average GDN will outperform on totex by 9.0%.
- If we assume that in fact an average GDN could actually achieve upper quartile performance on all ODIs, then our modelling finds that the underperformance wedge would still be 18 bps.
  - On this basis, the probability that a GDN could achieve 50 bps RoRE outperformance through other incentives would be 5.8%.
  - And Ofgem would need to believe that the average GDN could be expected to outperform its totex targets by 7.9%.

Our findings cast serious doubt over the validity of Ofgem's assumption that 50 bps of outperformance is a valid central assumption.

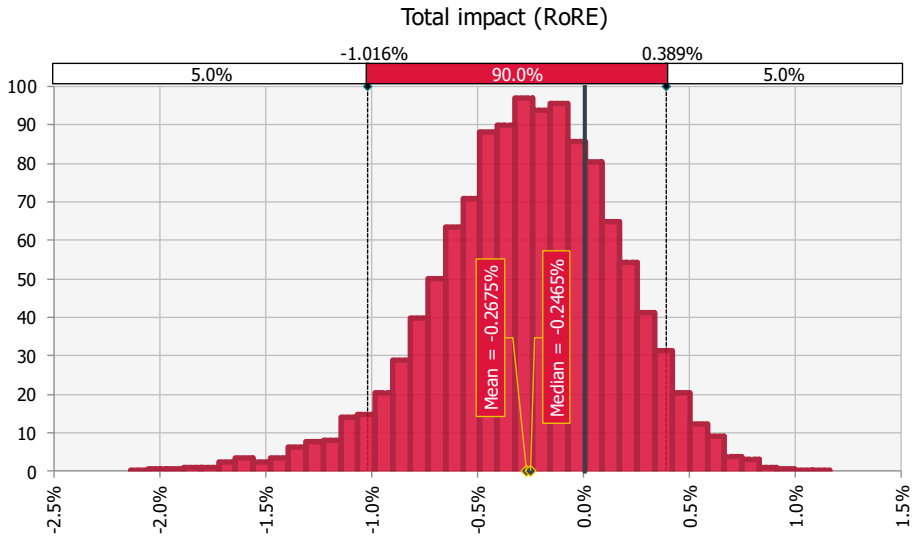
We explain our findings in more details below.

4.1.1 Core model

Our core model specification results in an estimated expectation of a 27bps underperformance in RoRE terms. This is equivalent to an absolute underperformance of £2.5m per year during the RIIO-GD2 price control period. The key drivers behind this underperformance are the Loss of Supply incentive (contributing 7bps of the underperformance), the Emergency Response Time incentive (5 bps) and the Guaranteed Standards of Performance (5 bps).

Figure 11 below shows the Monte Carlo simulation results of our core model, in the form of a probability distribution of potential RoRE outperformance outcomes.

Figure 11 Core model results in RoRE terms



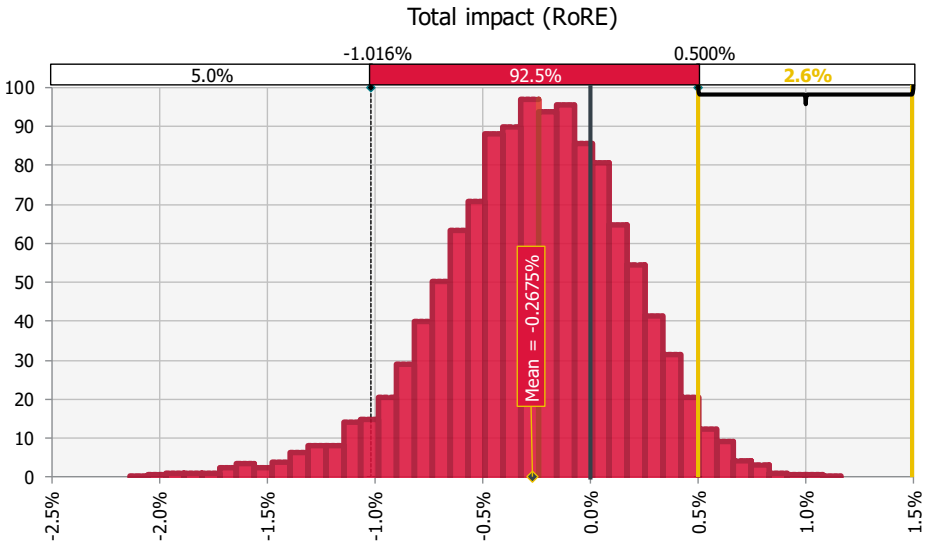
Source: Frontier analysis using @RISK

Note: The histogram above illustrates the probability distribution of a notional company's simulated out/underperformance in RoRE terms. The X-axis measures RoRE out/underperformance and the Y-axis measures the frequency of occurrences.

The horizontal axis shows financial outperformance in RoRE terms, and the vertical axis shows the frequency of occurrence in our simulation. As set out in our Methodology section above, our model randomly generates an outcome for each of our modelled incentives using the pre-defined probably distributions of each incentives. It then records the resulting RoRE outcome for that realisation. It does so for hundreds of iterations, each time recording one RoRE outcome. The diagram above shows the frequency of all iterations from the simulation.

The resulting distribution has a mean outcome of -26.8 bps in RoRE terms. It also shows that in 95% of the iterations, the resulting RoRE was lower than 38.9 bps. Finally, there are only 2.6% of the iterations where the outperformance was at or higher than 50 bps in RoRE terms, as show in Figure 12 below.

Figure 12 Estimated probability for 50 bps



Source: Frontier analysis using @RISK

Note: The histogram above illustrates the probability distribution of a notional company's simulated out/underperformance in RoRE terms. The X-axis measures RoRE out/underperformance and the Y-axis measures the frequency of occurrences.

Figure 13 below lists the estimated RoRE and financial contributions to the 27 bps underperformance by incentive group. Consumer-focused incentives account for the bulk of the expected underperformance whereas the Totex, BPI, Shrinkage & Leakage and NARMs incentives don't materially contribute to the performance estimate.

Figure 13 Incentive-level contributions to estimated underperformance

Incentive area	Mean RoRE contribution to out/underperformance (bps)	Mean financial contribution to out/underperformance (£m/year)	Financial contribution range[33] (£m/year)
Totex	-0.5	-0.05	-4.22 to 4.02
Business Plan Incentive	0.0	0.00	-3.46 to 3.46
Consumer focused incentives	-20.4	-1.87	-7.09 to 2.02
Emergency response time	-5.4	-0.50	-10.00 to 0.00
Shrinkage and leakage	0.0	0.00	-0.96 to 0.96
Network Asset Risk Metric	-0.5	-0.04	-0.33 to 0.00
Total impact (£)	**-26.8**	**-2.46**	**-9.36 to 3.58**

Source: Frontier analysis using @RISK

Note: All RoRE and financial results are presented accounting for correlations between incentives

It may be helpful to provide the intuition behind these base scenario results on a line by line basis.

- Our base scenario assumption is that totex outperformance at GD2 will be centred around zero. However, we model repex volume drivers limits as limiting the financial impact of totex outperformance but not limiting the financial impact of totex underperformance. This asymmetric financial impact of underlying totex performance leads to a small downside exposure on average.
- The BPI is assumed to be symmetric and uncorrelated with other incentives and therefore makes no expected contribution to our aggregate result.
- For customer focussed incentives, we have assumed the upper quartile calibration of targets lead to a set of incentives that the average firm will be unable to meet. This leads to a material contribution to the downside wedge.
- For shrinkage, we have assumed the target to be set as a "fair bet", therefore the expected value is zero.
- For NARMs, we have, as described above, assumed that there is no realistic prospect of upside reward, but there is some small possibility of a downside

[33] This range reports the central 90% of Monte Carlo simulation results for each metric, excluding the top and bottom 5% which may contain outliers.

materialising where a company fails to meet its NARMs target and fails to provide an acceptable justification to Ofgem. This leads to a modest downside.

4.1.2 Alternative model on ODIs

In line with Ofgem's stated methodology for GD2, we have set the target levels for output incentives equal to the upper-quartile of historical performance in GD1. This means that the notional company, where an average level of performance is assumed, is expected to underperform relative to these targets in GD2. This is a reasonable approach if past performance is a good indicator of future performance. However, this would also assume that no improvement to service quality can be achieved in RIIO2 compared to RIIO1 historic performance.

In this alternative model specification, we now assume that the average GDN will on average be expected to meet current upper quartile performance. This would be consistent with GDNs responding to stretching targets, that current performance suggests is presently beyond their capability, by improving performance so as to meet targets. We continue to assume that totex outperformance would be centred around zero, then shifted to the downside to account for the possibility that PCDs may not be delivered.

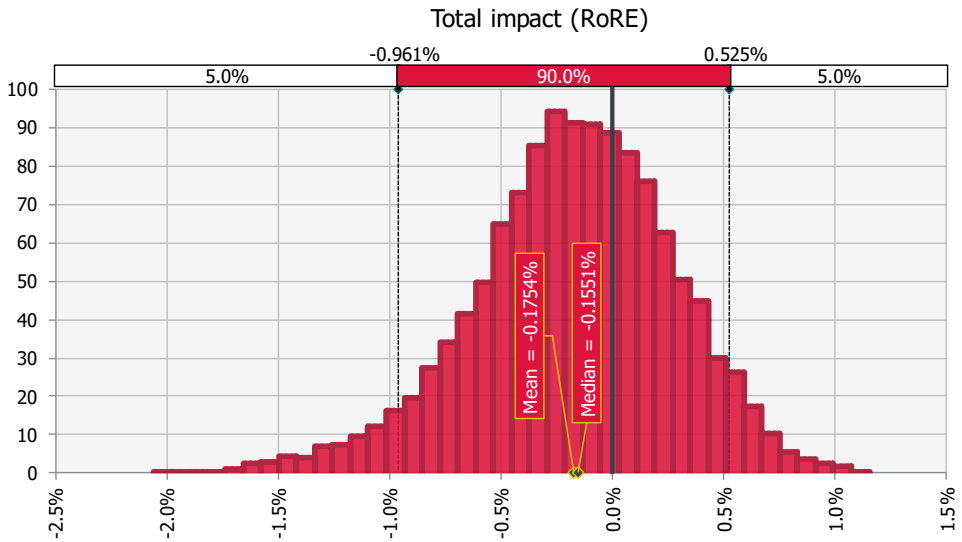
On this basis, we now find an estimated underperformance of 18 bps across the GD2 period. Of this 18 bps underperformance key contributions are from: the Emergency Response Time incentive (5 bps), the Guaranteed Standards of Performance (5 bps) and the Loss of Supply incentive (5 bps). Although under this alternative specification the Customer Satisfaction Survey incentive reports slight outperformance, on the whole the notional company is still expected to underperform due to the asymmetric nature of some financial payoffs.

The Customer Satisfaction Survey outperformance in the alternative specification can be explained by the fact that the maximum reward value and the mean performance is much closer to the target than the maximum penalty value, which increases the marginal reward for one unit of outperformance[34]. This in principle also applies to some of the other incentives, such as the Complaints Metrics and Loss of Supply. But as they are penalty only, no expected out-performance can materialise.

Finally, the net impact of the Totex incentive, once PCDs and sharing factors are accounted for, is skewed towards the downside. Taken altogether, this explains why estimated underperformance persists in this alternative specification.

[34] For the Customer Satisfaction Survey, Ofgem sets the target based on the upper quartile value estimated from historical performance. However, both the maximum reward and penalty are based on 1.5-1.75 standard deviations from the average historical performance. This means that the distance from the target to the maximum reward is less than from the target to maximum penalty, which results in a higher marginal reward for a unit of outperformance than the marginal penalty a unit of underperformance. The Customer Satisfaction Survey incentive is explained in further detail earlier in section 3.2.3.

Figure 14 Alternative model results in RoRE terms



Source: Frontier analysis using @RISK

Drawing on this distribution, we can report there are only 5.8% of the iterations where the outperformance was at or higher than 50 bps in RoRE terms.

4.1.3 Alternative model on Totex incentives

In our core model we have assumed that Ofgem's Totex allowance would be set such that it accurately reflects the cost that efficient GDNs on average would be able to achieve during GD2. For the purpose of the modelling, we have not sought to identify an actual level of the allowance, but rather directly modelled the Totex outperformance (which is set to zero on average in our core model).

However, Ofgem has suggested that companies would be able to outperform its allowance, almost regardless of where the allowance is set. We dispute this assertion, as it is clearly illogical to suggest that potential future outperformance is not dependent on how tough the allowance is set. Clearly it is Ofgem's intention to set tougher targets and to limit the extent of potential outperformance for the GDNs at GD2 when compared to GD1.

Nevertheless, we recognise that Ofgem may believe that some outperformance should be expected. There is therefore the value in understanding how potential Totex outperformance can translate into financial reward in RoRE terms.

In order to fully understand the implication of Ofgem's proposed 50 RoRE bps out-performance wedge assumption, in this section we report the outcome of using our modelling results to infer what level of expected totex outperformance one would need to anticipate in order for the expected totex outperformance wedge to be 50 bps as Ofgem has hitherto assumed.

We model this by using @RISK's goal-seek functionality. The goal-seek functionality tests different model specifications to achieve a desired simulation result.

This exercise revealed that a notional company would have to outperform relative to its totex targets by an average of 9.0% to achieve overall RoRE outperformance

of 50 bps (i.e. the totex distribution would have to be recalibrated with a mean out-performance of 9.0% to achieve 50 bps RoRE outperformance). Hence, in order for a 50 bps outperformance wedge to be justified, Ofgem would need to continue to believe that despite its best efforts to set tough targets, the average GDN will still outperform its totex allowance at GD2 by 9% in aggregate.

We can complete a similar calculation under our alternative modelling assumptions, where we assume that the average GDN can also achieve the upper quartile performance on all ODIs (i.e. that Ofgem sets stretching ODI incentives yet the average company is able to meet them in expectation). The resulting required totex out-performance is 7.9%.

4.2 Sensitivity analysis

In this section, we look at a set of alternative assumptions for certain aspects of our modelling that have the potential to change the results materially. We explore different values for key assumptions to ascertain the robustness of the core model result to these assumptions.

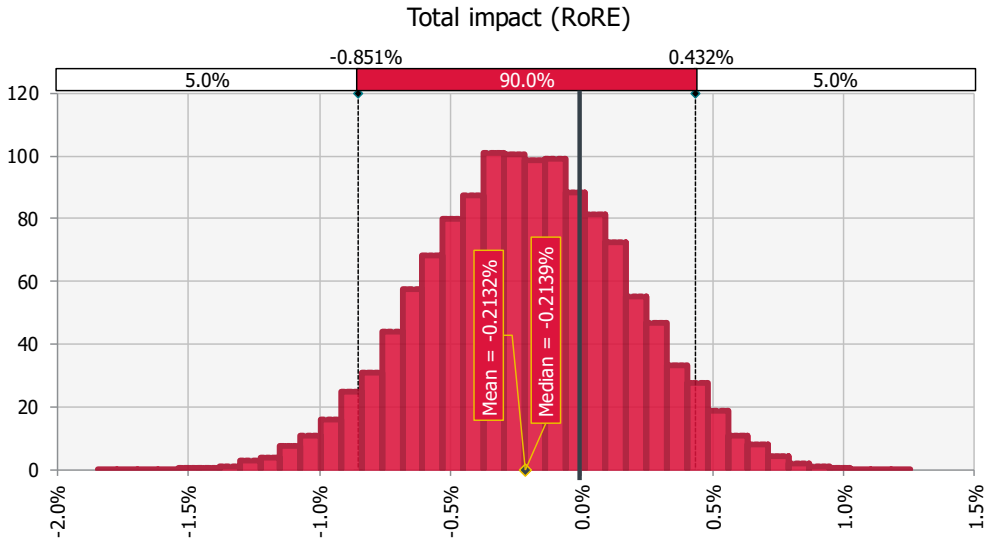
In particular, we look at:

- the calibrations of certain incentives;
  - Emergency response time; and
  - The Business Plan Incentive;
- the correlation assumptions we have made; and
- the RAV/Totex ratio.

4.2.1 Emergency Response Time

The first sensitivity examined involves excluding the Emergency Response Time ("ERT") incentive. As explained earlier, the ERT incentive is modelled on the basis that the networks are secured for 1 in 20 events. Therefore, there is approximately a 1 in 20 chance that weather events are beyond that which the network is design to meet and therefore might lead to GDNs failing to meet standards specified in their licence. In our core modelling, the expected, albeit rare, failure to meet ERT standards reduces a notional company's performance by approximately 5 bps.

Figure 15 RoRE underperformance remains after disabling the ERT incentive



Source: Frontier analysis using @RISK

Disabling the ERT incentive reduces the underperformance slightly, but an estimated 21 bps underperformance remains.

Figure 16 Consumer focused incentives drive underperformance after disabling ERT

Incentive area	Mean RoRE contribution to out/underperformance (bps)	Mean financial contribution to out/underperformance (£m/year)	Financial contribution range (£m/year)
Totex	-0.5	-0.05	-4.22 to 4.02
Business Plan Incentive	0.0	0.00	-3.46 to 3.46
Consumer focused incentives	-20.4	-1.87	-7.09 to 2.02
Emergency response time	0.0	0.00	0.00 to 0.00
Shrinkage and leakage	0.0	0.00	-0.96 to 0.96
Network Asset Risk Metric	-0.5	-0.04	-0.33 to 0.00
Total impact (£)	**-21.3**	**-1.96**	**-7.83 to 3.98**

Source: Frontier analysis using @RISK

Note: All RoRE and financial results are presented accounting for correlations between incentives

4.2.2 Business Plan Incentive

In the core model, we estimate BPI performance at a high level assuming that a notional company will not earn/incur any reward or penalty on average, and that the probability of a reward or penalty linearly decreases as the financial payoff approaches Ofgem's cap of ±2% of totex. This is reflected in the core model's specification where BPI performance is calibrated as a triangular distribution with a minimum value of -2%, a maximum value of 2% and a modal value of 0%. This

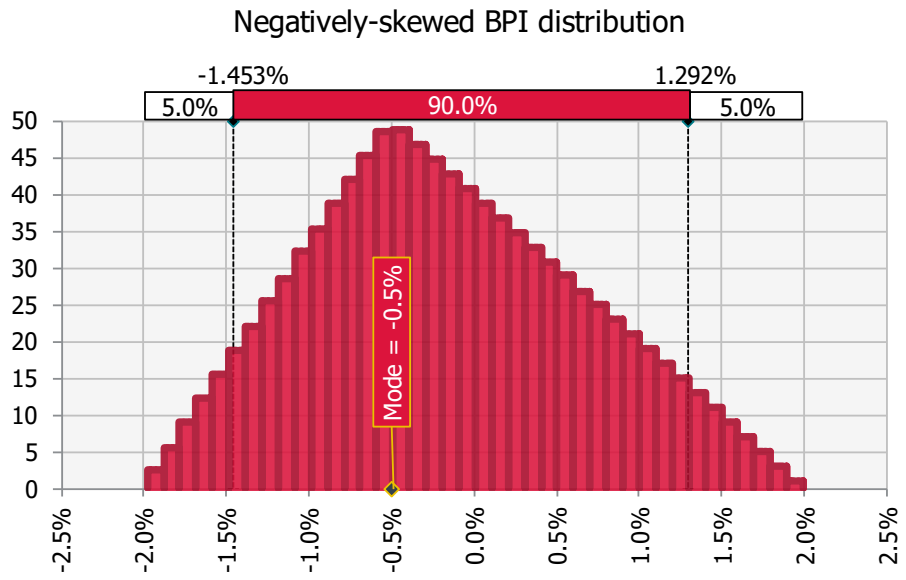
specification means that the Business Plan Incentive does not materially affect the notional company's average expected performance in our core model.

A skewed BPI impact

We also explored an alternative calibration of the BPI using a skewed triangular distribution. Whereas the core model assumes BPI performance is distributed symmetrically around the 0% under/outperformance value, an alternative specification examined the effect a negatively-skewed BPI distribution may have on overall performance. As shown in Figure 17, this distribution is also bounded by Ofgem's ±2% cap, however we have assumed a modal BPI performance to be slightly negative at -0.5%. This sensitivity reflects a scenario where there is assumed to be a higher probability that Ofgem awards penalties rather than issues rewards.

This alternative calibration might be considered a more accurate depiction of the BPI if there is a belief that Ofgem may choose to "fail" companies at stage 1 of the appraisal process if, for example, assumptions are put forward for key parameters such as the WACC that do not match Ofgem's own assumption. Whether this asymmetric calibration is more valid as a representation of the BPI is unknown at this stage and will depend on how Ofgem operationalises its proposals.

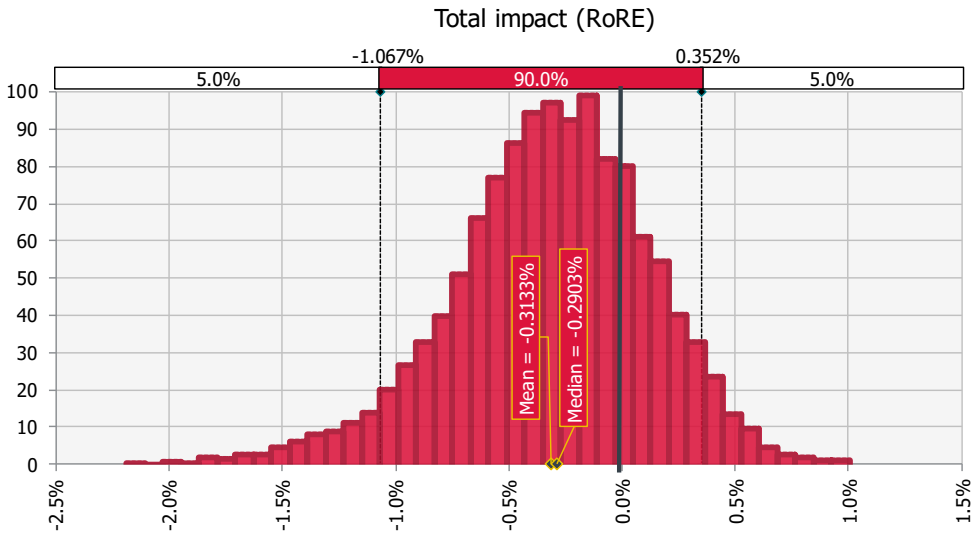
Figure 17 Alternative BPI specification



Source: Frontier analysis using @RISK

Under this alternative calibration of the BPI, overall underperformance increases to 31 bps. This increase in underperformance is driven by the recalibrated BPI, which adds approximately 5 bps to the underperformance.

Figure 18 RoRE underperformance increases under the skewed BPI specification



Source: Frontier analysis using @RISK

Figure 19 A recalibrated BPI increases underperformance by 5 bps

Incentive area	Mean RoRE contribution to out/underperformance (bps)	Mean financial contribution to out/underperformance (£m/year)	Financial contribution range (£m/year)
Totex	-0.5	-0.05	-4.22 to 4.02
Business Plan Incentive	-4.6	-0.42	-3.68 to 3.27
Consumer focused incentives	-20.4	-1.87	-7.09 to 2.02
Emergency response time	-5.4	-0.50	-10.00 to 0.00
Shrinkage and leakage	0.0	0.00	-0.96 to 0.96
Network Asset Risk Metric	-0.5	-0.04	-0.33 to 0.00
Total impact (£)	**-31.3**	**-2.89**	**-9.82 to 3.24**

Source: Frontier analysis using @RISK

Note: All RoRE and financial results are presented accounting for correlations between incentives

4.2.3 Correlations

As illustrated earlier in Figure 10, the core model includes what we consider to be relatively small correlations between totex and other incentives. To test the importance of these judgements in driving out results, we performed two sensitivities.

- in the first case, we doubled all correlations;
- in the alternative case, we set all these correlations to zero.

These changes are set out in Figure 20 below.

The results of both sensitivities do not differ from the core model as estimated underperformance remains at 27 bps. However, altering correlations does affect the range of the total estimated performance. As shown in Figure 21, doubling totex correlations marginally narrows the 90% confidence range[35] of the estimated performance whereas assuming no correlation results in a slightly wider range.

As the majority of totex correlation judgements are negative – i.e. a penalty in one incentive is correlated with an offsetting reward in another incentive, or vice versa – doubling the correlations results in greater offsetting of penalties and rewards, and thereby reducing the range of Monte Carlo simulation results. Disabling the totex correlations has the opposite effect: the mostly negative correlation judgements are removed, resulting in lower offsetting of penalties/rewards and a wider simulation range.

Nevertheless, the estimated average underperformance of 27 bps is present across the core model and both correlation sensitivities.

Figure 20 Sensitivities related to totex correlations

	Totex correlations – core model	Totex correlations – doubled	Totex correlations – no judgements applied
Totex	1.0	1.0	1.0
BPI	0.0	0.0	0.0
Planned interruptions	-0.2	-0.4	0.0
Emergency response & repair	-0.2	-0.4	0.0
Connections	-0.2	-0.4	0.0
Complaints metric	0.2	0.4	0.0
GSOP	0.0	0.0	0.0
Emergency response time	-0.2	-0.4	0.0
Avg. restoration time for unplanned interruptions	0.2	0.4	0.0
Shrinkage & leakage	0.0	0.0	0.0
NARM	-0.5	-0.5	0.0

Source: Frontier Economics

Note: In the sensitivity with doubled correlations, the totex-NARM correlation is left unchanged from the core model specification. This is because @RISK flags an error when a larger negative correlation is specified.

[35] This range reported in Figure 21 contains the central 90% of Monte Carlo simulation results for total performance, excluding the top and bottom 5% which may contain outliers.

Figure 21 Altering totex correlations affects the range, not mean value, of the estimated performance

Scenario	Mean estimated performance (RoRE, £m/year)	RoRE range (bps)	Financial range (£m/year)
Core model	-26.8 bps, - £2.46m	-101.6 to 38.9	-9.36 to 3.58
Totex correlations doubled	-26.8 bps, - £2.46m	-100.5 to 35.7	-9.26 to 3.29
Totex correlations disabled	-26.8 bps, - £2.46m	-102.9 to 42.3	-9.48 to 3.90

Source: Frontier analysis using @RISK

This sensitivity suggests that the exact calibration of the correlation matrix does not have a significant impact on the mean performance results. However, altering the correlations does impact the dispersion of results. Under the core specification, 95% of simulation observations lie below 38.9 bps outperformance implying there's only a 5% chance that a notional company outperforms further. When totex correlations are doubled, the dispersion of observations decreases and 5% results are greater than 35.7 bps outperformance. When the correlation judgements are removed, the dispersion widens and the top 5% of results indicate performance beyond 42.3 bps.

4.2.4 RAV to Totex Ratio

Our analysis of Ofgem's proposed outperformance wedge attempts to consider out/underperformance from the perspective of a notional company. However, for the purposes of examining bottom-up performance, we have had to refer to financial metrics to calculate payoffs for most incentives. This is because RoRE calculations require RAV value and that many incentive payoffs are linked to metrics such as allowed totex or revenues. For example, the Customer Satisfaction Survey incentives are linked to a company's allowed revenues and the maximum penalty or reward is capped at ±0.5% of revenues.

To this end, we have used forecasts provided by NGN for GD2. To examine whether NGN's forecasts are a reasonable reference point to use for the notional company, we compared the NGN forecast GD2 RAV/Totex ratio with GD1 ratios. This ratio is also important to examine as GD1 data was used to calculate incentive-level distributions and correlations. Comparing NGN's forecast RAV/Totex to GD1 levels at both the network-level (Figure 22) and company-level (Figure 23) reveals that the ratio is relatively stable both across companies and the NGN's GD2 forecast is reasonably representative of a notional GDN.

Figure 22 Network-level RAV/Totex ratios

Network	RIIO-GD1 avg. RAV (£ 2009)	RIIO-GD1 avg. totex allowance (£ 2009)	RAV/Totex
East	2443.7	263.0	9.3
London	1686.6	228.9	7.4
North West	1703.8	196.1	8.7
West Midlands	1288.4	150.8	8.5
Northern Gas	**1597.6**	**201.7**	**7.9**
Scotland	1285.4	158.9	8.1
Southern	2858.2	325.7	8.8
Wales and South West	1619.0	201.6	8.0
Northern Gas RIIO-GD2 forecast			**9.1**

Source: Frontier analysis using Ofgem's RIIO-GD1 financial model and NGN forecasts

Figure 23 Company-level RAV/Totex ratios

Company	RIIO-GD1 avg. RAV (£ 2009)	RIIO-GD1 avg. totex allowance (£ 2009)	RAV/Totex
Cadent	7122.5	838.8	8.5
Northern Gas	**1597.6**	**201.7**	**7.9**
Wales & West	1619.0	201.6	8.0
SGN	4143.6	484.6	8.6
Northern Gas RIIO-GD2 forecast			**9.1**

Source: Frontier analysis using Ofgem's RIIO-GD1 financial model and NGN forecasts

The above results broadly validates our use of NGN's forecast on RAV and Totex for GD2, and it suggests that our analysis and results do not lose generality for the rest of the GD sector.

4.3 Conclusions and interpretations of the results

Our core model and most alternative model specifications suggest that the average GDNs in GD2 should expect to underperform by 27 bps. This result arises as a result of:

- Our neutral modelling assumptions around totex;
- Our assumption that ODI targets set at an upper quartile level would not be met by an average firm; and
- Owing to a number of downside only instruments.

These results are broadly robust to a range of different assumptions, including alternative calibration of ODIs, Business Plan Incentives and Emergency Response Time incentives, correlation between incentives and RAV/Totex ratios.

Clearly the treatment of totex outperformance is a key determinant of this finding. However, it is important to stress that we use our main assumption in respect of

totex as a base assumption from which to derive what is perhaps the more interesting result, i.e. what level of average totex outperformance would one need to expect to see in order for it to be valid to assume a 50 bps expected outperformance wedge. The answer is that a very large and sustained average outperformance – 9% across the sector in aggregate over the period - needs to be assumed. It feels incongruous to say the least to simultaneously take the view that Ofgem will strive to set stretching targets for the entire sector, while at the same time assuming an outperformance wedge that can only be justified by assuming totex outperformance from the entire sector at 9%. Ofgem will need to square this circle if it intends to maintain its position on the 50 bps.

Overall, following a detailed modelling investigation into all of the incentive mechanisms that we understand will be included in the GD2 framework, we have not identified a reasonable basis on which one could assume that an average GDN can be expected to outperform by 50 bps in RoRE terms.

There are of course limits to our modelling as a result of:

- data limitations;
- limitations on the level of explanation Ofgem has so far provided on how it intends some incentives to be calibrated and operated; and
- the inherently uncertain nature of outcomes of incentive mechanisms.

The exact choice of the assumptions can of course be subject to debate and potentially further study. However, we consider that this study can serve as a starting point for the regulator to robustly assess companies' potential outperformance within the price control. Should Ofgem set out further details of how certain instruments will be set up, this can be incorporated into our modelling.

Finally, we note that one interpretation of our finding of expected underperformance may be that rather than applying a deduction to the headline cost of equity, Ofgem should apply an uplift. We would encourage the reader not to reach this view. We disagree in principle with Ofgem's proposition that the allowed return on equity should be adjusted to account for expected outperformance (or indeed under-performance).

ANNEX A DETAILED ANALYTICAL INPUTS AND RESULTS

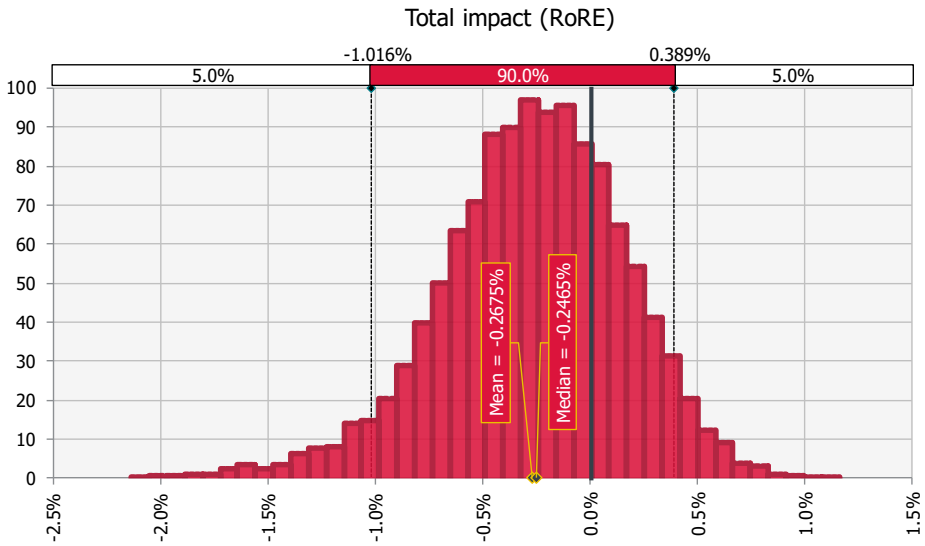
1. Core specification

Figure 24 Core model incentive-level results

Incentive area	Mean RoRE contribution (bps)	Mean financial contribution[36] (£m/year)	Financial contribution range (£m/year)
Totex	-0.5	-0.05	-4.22 to 4.02
Business Plan Incentive	0.0	0.00	-3.46 to 3.46
CSS: Planned Interruptions	-1.9	-0.18	-0.67 to 0.67
CSS: Emergency Response and Repair	-1.8	-0.16	-0.67 to 0.67
CSS: Connections	-2.0	-0.19	-0.67 to 0.67
Complaints metric	-2.0	-0.19	-1.75 to 0.00
GSOP	-5.4	-0.50	-1.29 to 0.00
Emergency response time	-5.4	-0.50	-10.00 to 0.00
Loss of supply	-7.2	-0.66	-2.02 to 0.00
Shrinkage and leakage	0.0	0.00	-0.96 to 0.96
Network Asset Risk Metric	-0.5	-0.04	-0.33 to 0.00
Total impact (£)	**-26.8**	**-2.46**	**-9.36 to 3.58**

Source: Frontier analysis using @RISK
Note: All RoRE and financial results are presented accounting for correlations between incentives

Figure 25 Core model results in RoRE terms

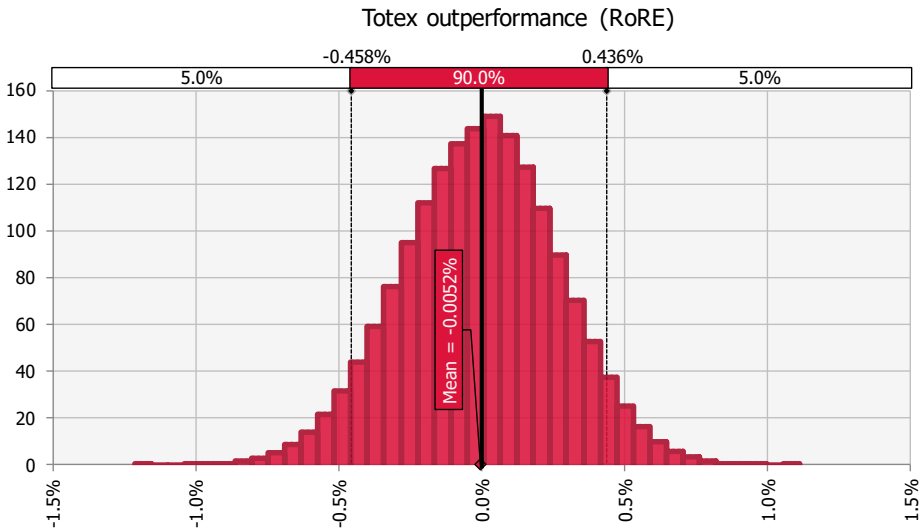


Source: Frontier analysis using @RISK

Note: The histogram above illustrates the probability distribution of a notional company's simulated out/underperformance in RoRE terms. The X-axis measures RoRE out/underperformance and the Y-axis measures the frequency of occurrences.

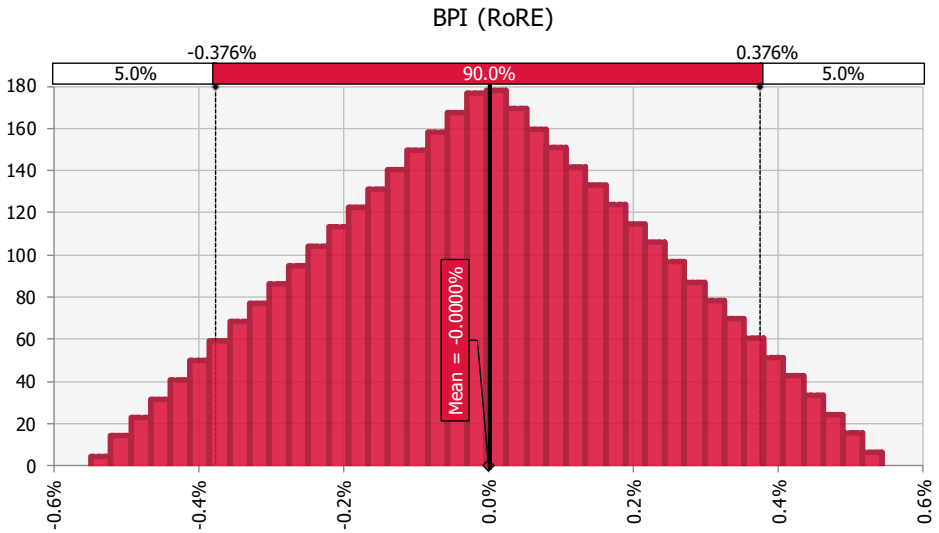
[36] This range reports the central 90% of Monte Carlo simulation results for each metric, excluding the top and bottom 5% which may contain outliers.

Figure 26 Totex outperformance results in RoRE terms



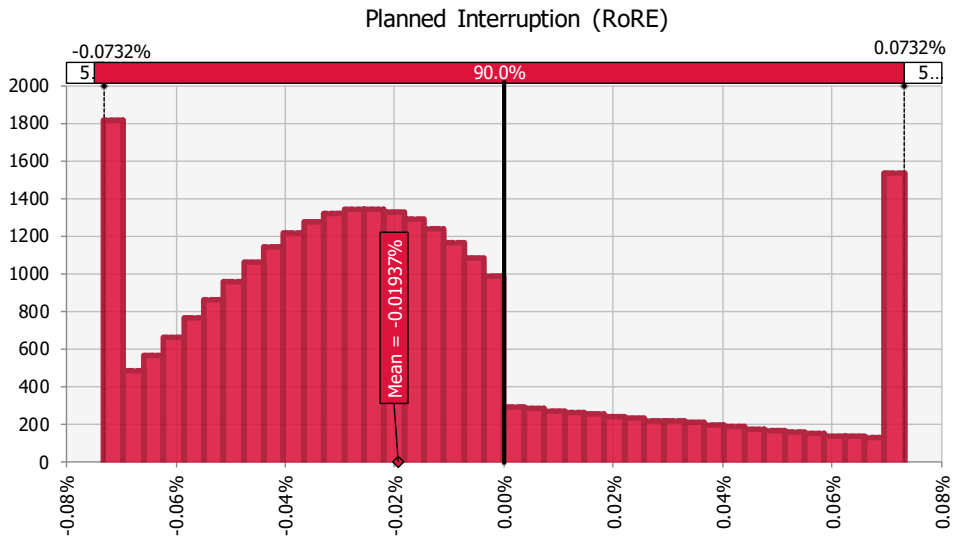
Source: Frontier analysis using @RISK

Figure 27 BPI outperformance results in RoRE terms



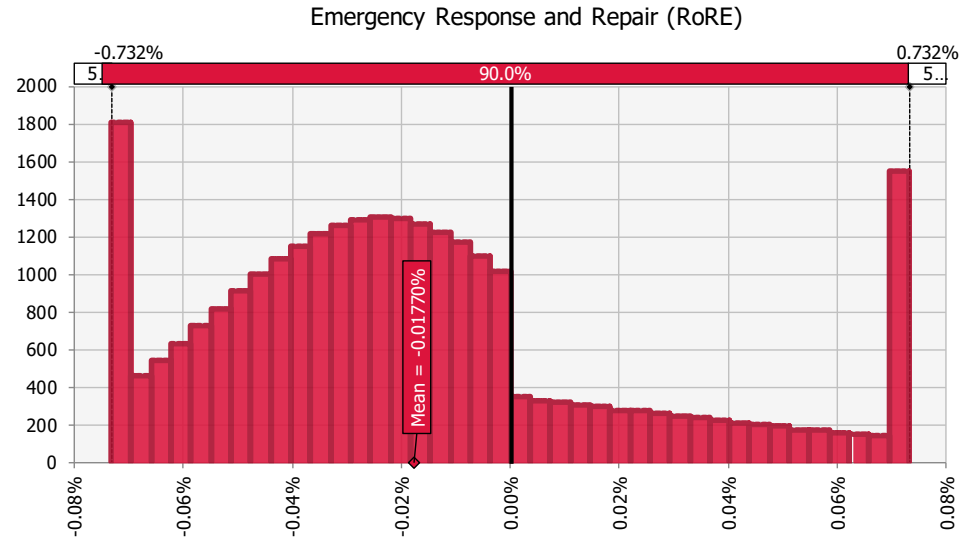
Source: Frontier analysis using @RISK

Figure 28 Customer Satisfaction Survey: Planned interruptions outperformance results in RoRE terms



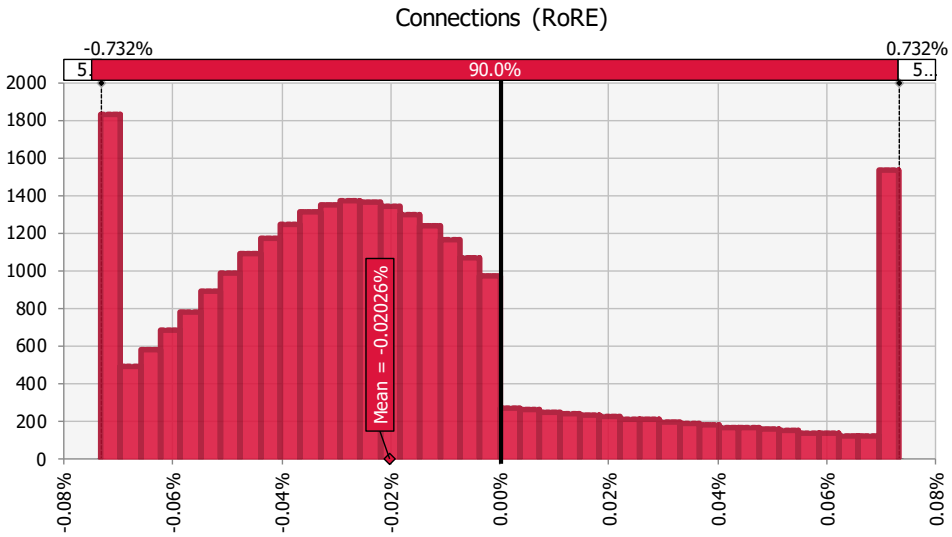
Source: Frontier analysis using @RISK

Figure 29 Customer Satisfaction Survey: Emergency Response and Repairs outperformance results in RoRE terms



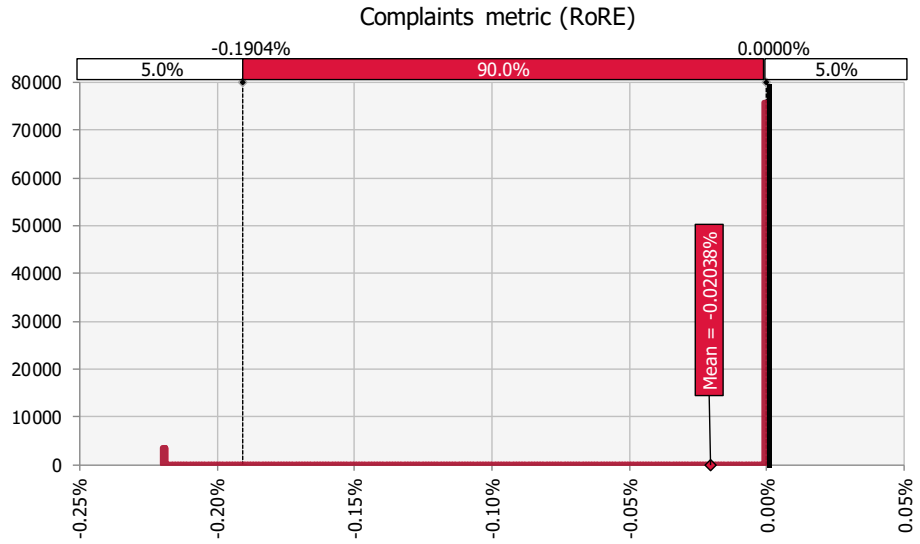
Source: Frontier analysis using @RISK

Figure 30 Customer Satisfaction Survey: Connections outperformance results in RoRE terms



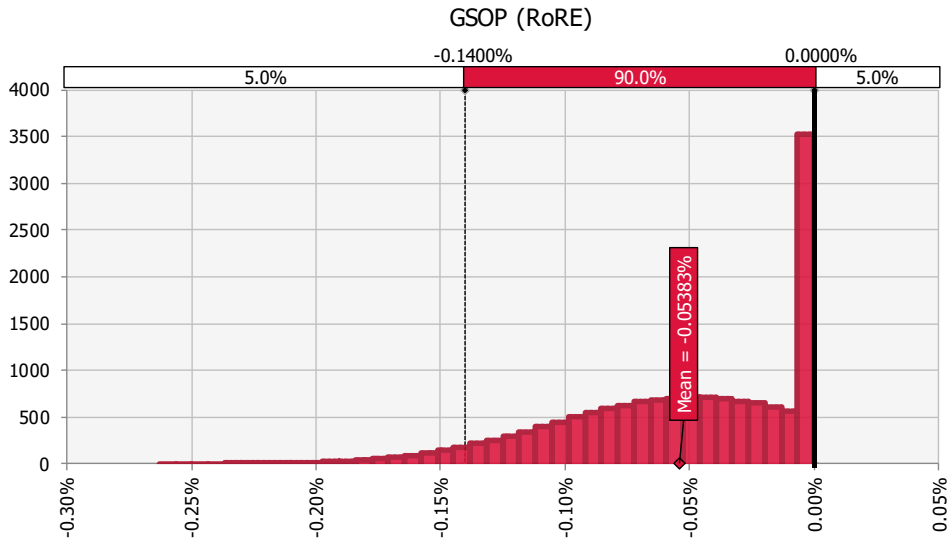
Source: Frontier analysis using @RISK

Figure 31 Complaints metric outperformance results in RoRE terms



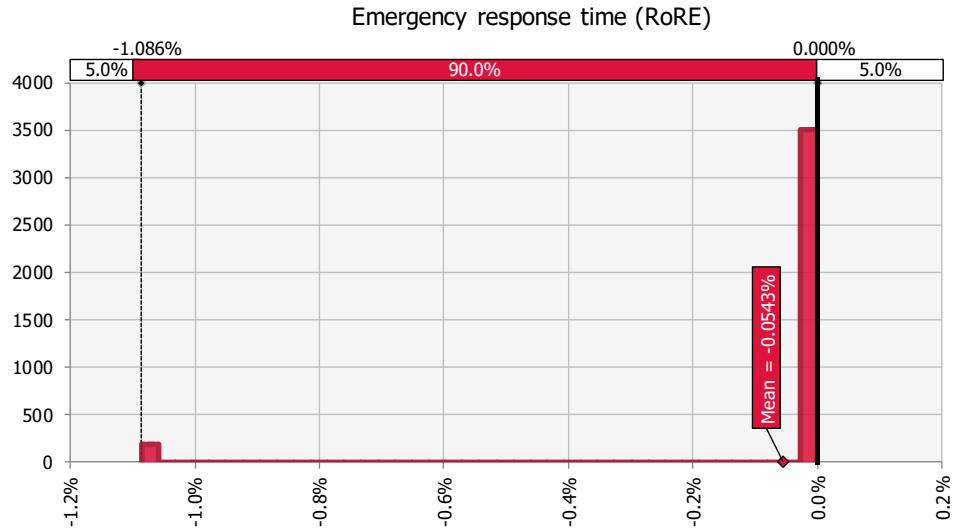
Source: Frontier analysis using @RISK

Figure 32 GSOP outperformance results in RoRE terms



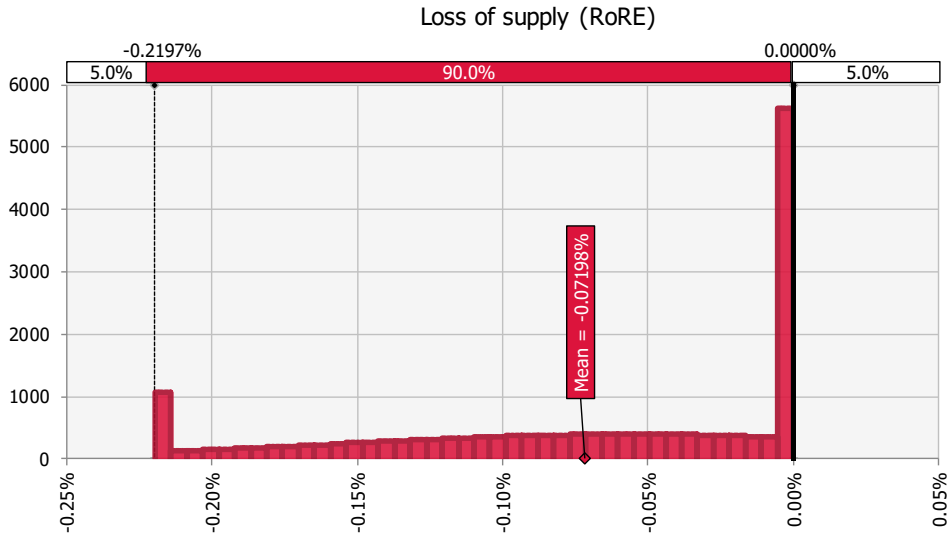
Source: Frontier analysis using @RISK

Figure 33 Emergency Response Time outperformance results in RoRE terms



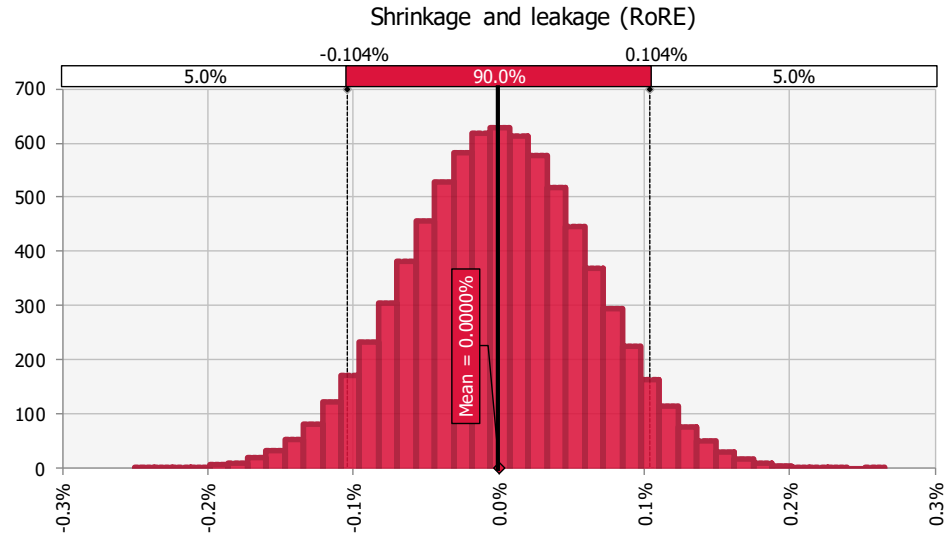
Source: Frontier analysis using @RISK

Figure 34 Loss of supply outperformance results in RoRE terms



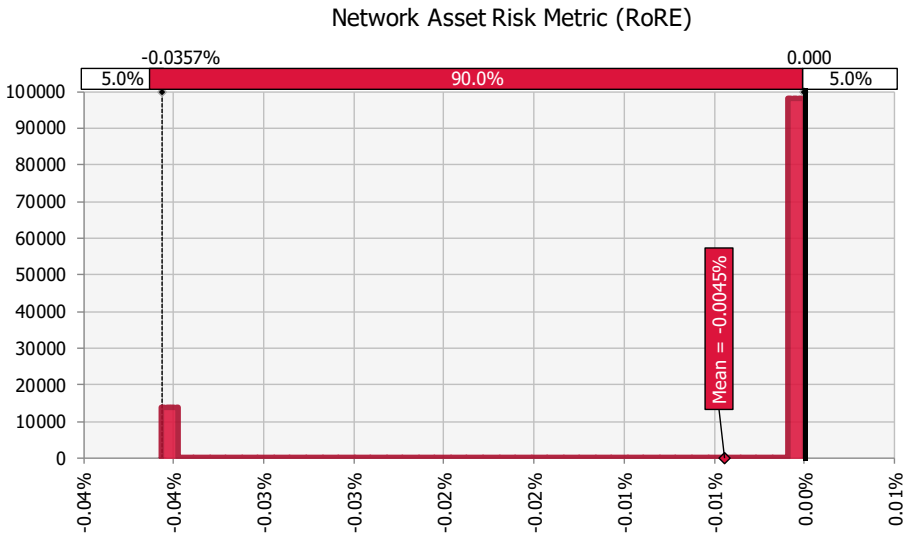
Source: Frontier analysis using @RISK

Figure 35 Shrinkage & Leakage outperformance results in RoRE terms



Source: Frontier analysis using @RISK

Figure 36 Network Asset Risk Metric outperformance results in RoRE terms



Source: Frontier analysis using @RISK

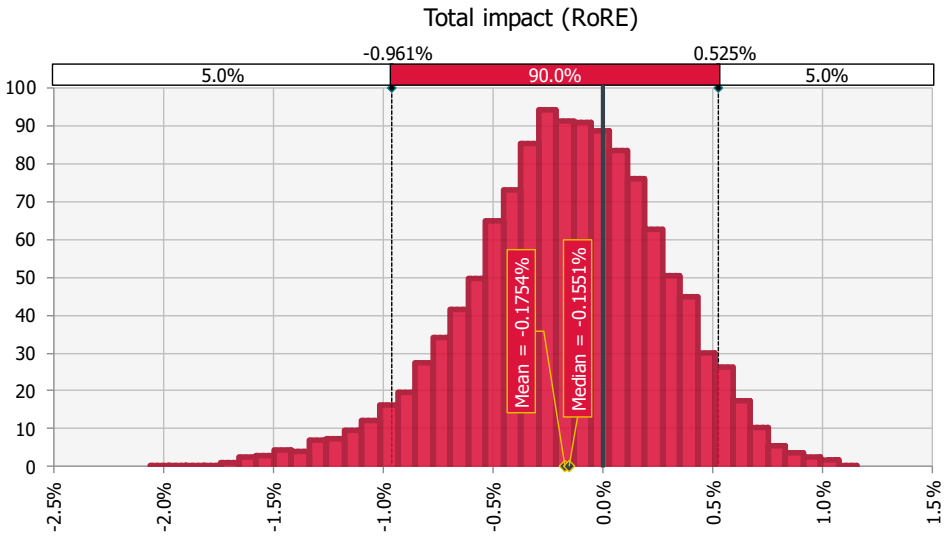
2. Alternative specification

Figure 37 Alternative model incentive-level results

Incentive area	Mean RoRE contribution (bps)	Mean financial contribution (£m/year)	Financial contribution range (£m/year)
Totex	-0.5	-0.05	-4.22 to 4.02
Business Plan Incentive	0.0	0.00	-3.46 to 3.46
CSS: Planned Interruptions	1.4	0.13	-0.45 to 0.67
CSS: Emergency Response and Repair	1.3	0.12	-0.46 to 0.67
CSS: Connections	1.5	0.14	-0.44 to 0.67
Complaints metric	-4.8	-0.44	-1.90 to 0.00
GSOP	-5.4	-0.50	-1.29 to 0.00
Emergency response time	-5.4	-0.50	-10.00 to 0.00
Loss of supply	-5.1	-0.47	-2.02 to 0.00
Shrinkage and leakage	0.0	0.00	-0.96 to 0.96
Network Asset Risk Metric	-0.5	-0.04	-0.33 to 0.00
Total impact (£)	**-17.5**	**-1.62**	**-8.85 to 4.84**

Source: Frontier analysis using @RISK
Note: All RoRE and financial results are presented accounting for correlations between incentives

Figure 38 Alternative model results in RoRE terms



Source: Frontier analysis using @RISK

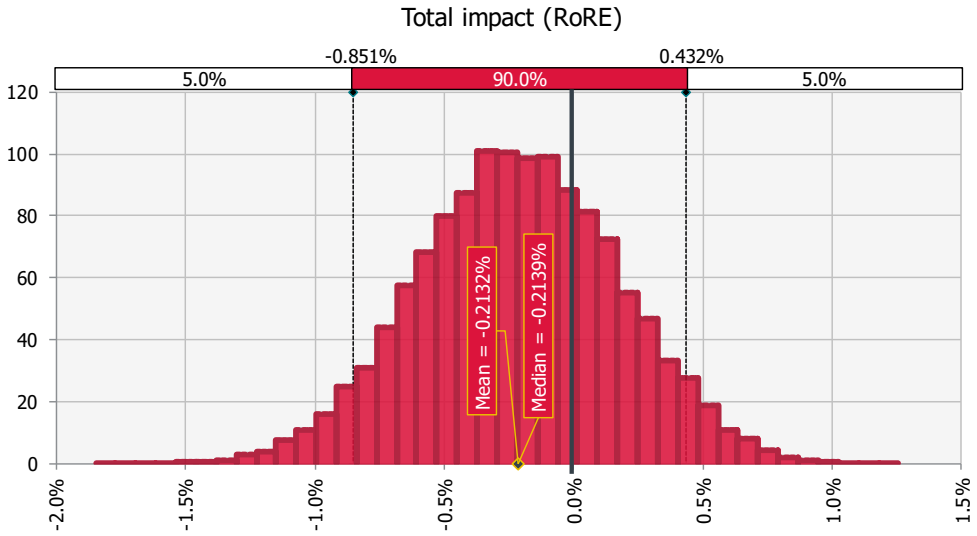
3. Disabling Emergency Response Time sensitivity

Figure 39 Disabling ERT sensitivity incentive-level results

Incentive area	Mean RoRE contribution (bps)	Mean financial contribution (£m/year)	Financial contribution range (£m/year)
Totex	-0.5	-0.05	-4.22 to 4.02
Business Plan Incentive	0.0	0.00	-3.46 to 3.46
CSS: Planned Interruptions	-1.9	-0.18	-0.67 to 0.67
CSS: Emergency Response and Repair	-1.8	-0.16	-0.67 to 0.67
CSS: Connections	-2.0	-0.19	-0.67 to 0.67
Complaints metric	-2.0	-0.19	-1.75 to 0.00
GSOP	-5.4	-0.50	-1.29 to 0.00
Emergency response time	0.0	0.00	0.00 to 0.00
Loss of supply	-7.2	-0.66	-2.02 to 0.00
Shrinkage and leakage	0.0	0.00	-0.96 to 0.96
Network Asset Risk Metric	-0.5	-0.04	-0.33 to 0.00
Total impact (£)	**-21.3**	**-1.96**	**-7.83 to 3.98**

Source: Frontier analysis using @RISK
Note: All RoRE and financial results are presented accounting for correlations between incentives

Figure 40 Disabling ERT model results in RoRE terms



Source: Frontier analysis using @RISK

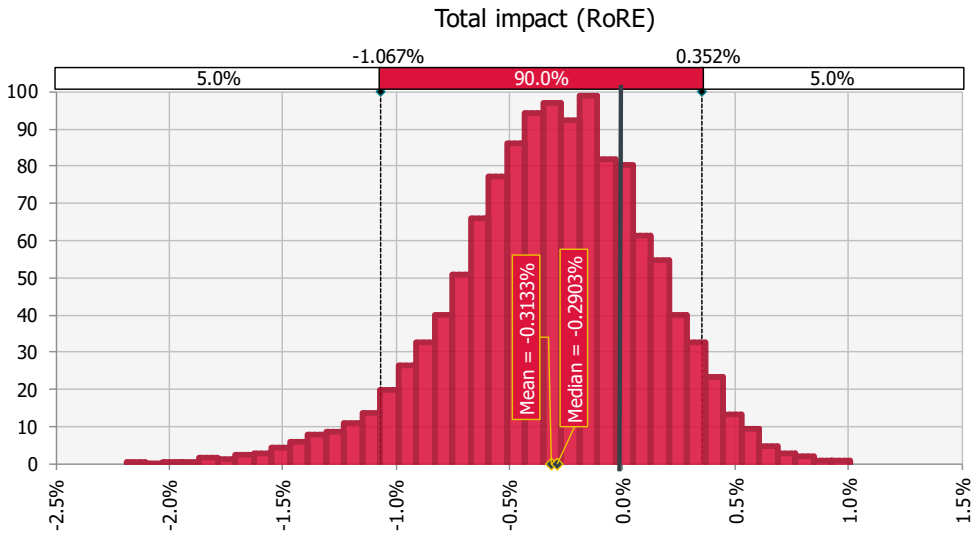
4. Skewed BPI distribution sensitivity

Figure 41 Skewed BPI sensitivity incentive-level results

Incentive area	Mean RoRE contribution (bps)	Mean financial contribution (£m/year)	Financial contribution range (£m/year)
Totex	-0.5	-0.05	-4.22 to 4.02
Business Plan Incentive	-4.6	-0.42	-3.68 to 3.27
CSS: Planned Interruptions	-1.9	-0.18	-0.67 to 0.67
CSS: Emergency Response and Repair	-1.8	-0.16	-0.67 to 0.67
CSS: Connections	-2.0	-0.19	-0.67 to 0.67
Complaints metric	-2.0	-0.19	-1.75 to 0.00
GSOP	-5.4	-0.50	-1.29 to 0.00
Emergency response time	-5.4	-0.50	-10.00 to 0.00
Loss of supply	-7.2	-0.66	-2.02 to 0.00
Shrinkage and leakage	0.0	0.00	-0.96 to 0.96
Network Asset Risk Metric	-0.5	-0.04	-0.33 to 0.00
Total impact (£)	**-31.3**	**-2.89**	**-9.82 to 3.24**

Source: Frontier analysis using @RISK
Note: All RoRE and financial results are presented accounting for correlations between incentives

Figure 42 Skewed BPI model results in RoRE terms



Source: Frontier analysis using @RISK

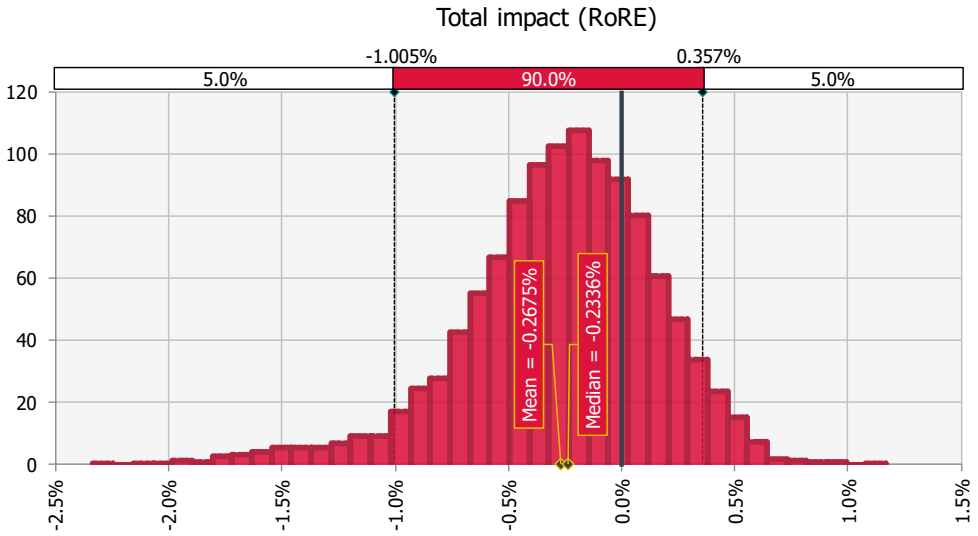
5. Totex correlations doubled sensitivity

Figure 43 Totex correlations doubled sensitivity incentive-level results

Incentive area	Mean RoRE contribution (bps)	Mean financial contribution (£m/year)	Financial contribution range (£m/year)
Totex	-0.5	-0.05	-4.22 to 4.02
Business Plan Incentive	0.0	0.00	-3.46 to 3.46
CSS: Planned Interruptions	-1.9	-0.18	-0.67 to 0.67
CSS: Emergency Response and Repair	-1.8	-0.16	-0.67 to 0.67
CSS: Connections	-2.0	-0.19	-0.67 to 0.67
Complaints metric	-2.0	-0.19	-1.75 to 0.00
GSOP	-5.4	-0.50	-1.29 to 0.00
Emergency response time	-5.4	-0.50	-10.00 to 0.00
Loss of supply	-7.2	-0.66	-2.02 to 0.00
Shrinkage and leakage	0.0	0.00	-0.96 to 0.96
Network Asset Risk Metric	-0.5	-0.04	-0.33 to 0.00
Total impact (£)	**-26.8**	**-2.46**	**-9.26 to 3.29**

Source: Frontier analysis using @RISK
Note: All RoRE and financial results are presented accounting for correlations between incentives

Figure 44 Totex correlations doubled model results in RoRE terms



Source: Frontier analysis using @RISK

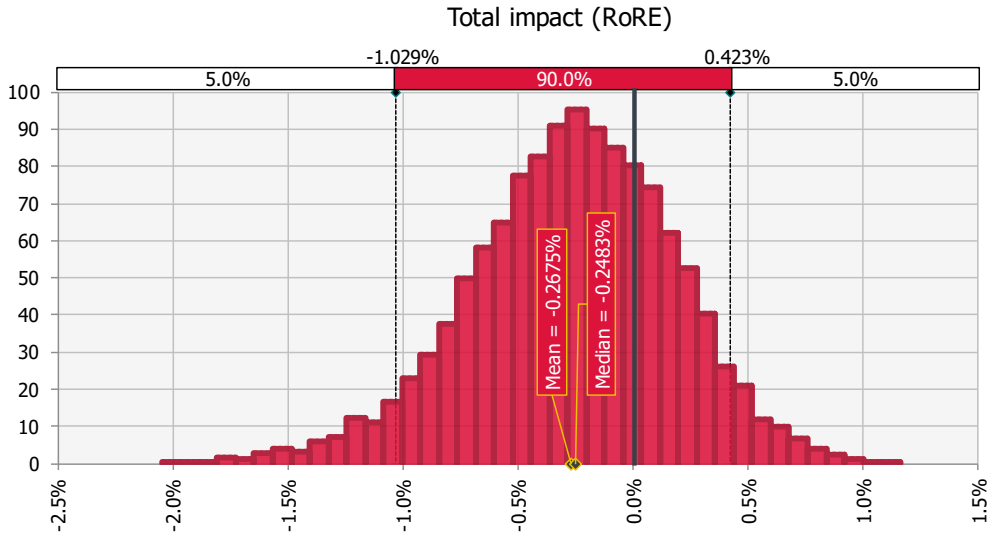
6. Totex correlations disabled sensitivity

Figure 45 Totex correlations disabled sensitivity incentive-level results

Incentive area	Mean RoRE contribution (bps)	Mean financial contribution (£m/year)	Financial contribution range (£m/year)
Totex	-0.5	-0.05	-4.22 to 4.02
Business Plan Incentive	0.0	0.00	-3.46 to 3.46
CSS: Planned Interruptions	-1.9	-0.18	-0.67 to 0.67
CSS: Emergency Response and Repair	-1.8	-0.16	-0.67 to 0.67
CSS: Connections	-2.0	-0.19	-0.67 to 0.67
Complaints metric	-2.0	-0.19	-1.75 to 0.00
GSOP	-5.4	-0.50	-1.29 to 0.00
Emergency response time	-5.4	-0.50	-10.00 to 0.00
Loss of supply	-7.2	-0.66	-2.02 to 0.00
Shrinkage and leakage	0.0	0.00	-0.96 to 0.96
Network Asset Risk Metric	-0.5	-0.04	-0.33 to 0.00
Total impact (£)	**-26.8**	**-2.46**	**-9.48 to 3.90**

Source: Frontier analysis using @RISK
Note: All RoRE and financial results are presented accounting for correlations between incentives

Figure 46 Totex correlations disabled model results in RoRE terms



Source: Frontier analysis using @RISK

ANNEX B CORRELATION MATRIX

Figure 47 Correlation matrix used in core specification

	Totex outperf.	BPI	Plan int.	Emerg. resp. & rep.	Conn.	Comp metric	GSOP	Emergency resp. time	Avg rest. time	S&L	NARMs
Totex outperf.	1										
BPI	0	1									
Planned int.	-0.2	0	1								
Emergency response & repair	-0.2	0	0.58	1							
Connections	-0.2	0	0.73	0.87	1						
Complaints metric	0.2	0	-0.82	-0.77	-0.79	1					
GSOP	0	0	-0.44	-0.61	0.74	0.48	1				
Emergency response time	-0.2	0	0.52	0.40	0.59	-0.42	0.61	1			
Avg. restoration time for unplanned int.	0.2	0	-0.32	-0.28	-0.43	0.27	-0.39	-0.61	1		
Shrinkage & leakage	0	0	0	0	0	0	0	0	0	1	
NARMs	-0.5	0	0	0	0	0	0	0	0	0	1

Source: Frontier Economics judgements and calculations using RIIO-GD1 outturn data
Note: Teal shaded = derived from data, Red shaded = assumed value (we test a sensitivity for this)

Figure 48 Model units

Measure	Modelled as	Implication on RoRE performance
Totex outperformance	% outperformance (i.e. % totex underspend)	Greater estimated value -> Greater RoRE outperformance
Business Plan Incentive	% totex reward or penalty (±2% cap on reward/penalty)	Greater estimated value -> Greater RoRE outperformance
CSS - Planned interruptions	Survey score, higher value implies better performance	Greater estimated value -> Greater RoRE outperformance
CSS - Emergency response and repair	Survey score, higher value implies better performance	Greater estimated value -> Greater RoRE outperformance
CSS - Connections	Survey score, higher value implies better performance	Greater estimated value -> Greater RoRE outperformance
Complaints metric	Metric score, higher value implies worse performance	Greater estimated value -> Lower RoRE outperformance
Guaranteed Standards of Performance	GSOP payment (penalty) per customer	Greater estimated value -> Lower RoRE outperformance
Emergency response time (controlled emergencies, 2h standard)	Binary value: 1 implies failure to meet standard	Greater estimated value -> Lower RoRE outperformance
Average restoration time for total unplanned interruptions	Average time in hours taken to restore service	Greater estimated value -> Lower RoRE outperformance
Shrinkage & leakage	Shrinkage performance in GWh	Greater estimated value -> Greater RoRE outperformance
Network Asset Risk Metric	Binary value: 1 implies failure to meet standard	Greater estimated value -> Lower RoRE outperformance

Source: Frontier Economics

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