SHRINKAGE INCENTIVE ANALYSIS

A note from AFRY Management Consulting to Ofgem

24th January 2020

NGGT SHRINKAGE INCENTIVE ANALYSIS

1. INTRODUCTION

Ofgem commissioned a partnership of CEPA, AFRY Management Consulting (AFRY) and Economic Consulting Associates (ECA) to provide economic advice for RIIO-2. This internal note has been prepared by AFRY under this Economic Strategic Partner contract for RIIO-2.

This note briefly introduces the current NTS shrinkage incentive mechanism and examines performance under RIIO-T1. It examines the current incentive design, and discusses the design proposed by National Grid Gas Transmission (NGGT) for RIIO-2 in its December 2019 Business Plan.

1.1.1 Shrinkage concepts

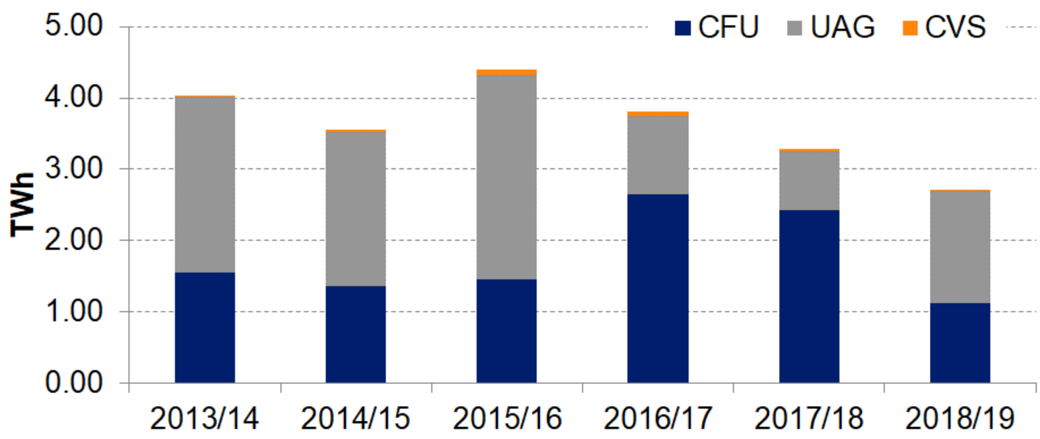
The term shrinkage refers to a concept that the volume of gas exiting a gas network was smaller than the volume of gas entering the gas network, i.e. it 'shrinks' as it moves through the system.

In relation to the National Transmission System (NTS), shrinkage refers to three components:

- compressor fuel usage (**CFU**), which comprises gas and electricity as fuel elements, and refers to the energy used to provide compression on the NTS;
- calorific value (CV) shrinkage (**CVS**), which refers to gas lost as a result of the variation in CV across a local area breaching the cap imposed by the Gas (Calculation of Thermal Energy) Regulations 1996; and
- unaccounted for gas (**UAG**), which is gas that is not otherwise accounted for and arises primarily due to inaccuracies in metering.

The total shrinkage volume in 2018/19 was 2.7 TWh, and over the first six years of RIIO1 it has averaged 3.6 TWh. Typically, CVS accounts for a very small share of shrinkage volume, at around 1% over RIIO-T1 to date. CFU and UAG volumes have been roughly equal at 46% and 53% of shrinkage, although there is a large variance from year to year, with CFU's share of shrinkage volumes ranging between 34% and 74%, and UAG in the range of 24% to 65%[1]. Shrinkage volumes are shown in Figure 1below.

Figure 1 – Shrinkage volumes over RIIO-T1



Source: NGGT- https://www.nationalgridgas.com/balancing/unaccounted-gas-uag

The Uniform Network Code (UNC) requires that NGGT procure shrinkage, thus ensuring system balance.

1.1.2 Ofgem's position

Ofgem's Sector Specific Methodology Decision (SSMD) for gas transmission[2] put forward a proposed decision to retain a shrinkage incentive in RIIO-2 but to remove the CFU element from the incentive. CFU would continue to be retained as a cost pass-through item (i.e. it would not be included within the totex allowance), and forecasting and reporting requirements would be retained.

Ofgem's proposed decision was contingent on NGGT providing Ofgem with evidence that the UAG and CVS elements were under NGGT's control and that there were consumer benefits from incentivising procurement of these two elements of shrinkage.

1.1.3 Scope

Ofgem specified our scope for this note as follows:

- "test if the CFU data shows that … there is no value in the CFU element";
- "test if we can dispense with the target and rely on the cash-out price for the UAG and CVS elements"; and
- "[test] if there is value in incentivising shrinkage".

Our analysis has involved an examination of the performance under RIIO-T1, a review of the incentive design and a review of NGGT's December Business Plan. Our analysis is

1 See rows B5(i) and B5(iii) in Table 1.

2 https://www.ofgem.gov.uk/system/files/docs/2019/05/riio-2_sector_specific_methodology_decision_-_gt.pdf

based on data supplied to Ofgem by NGGT through the Regulatory Reporting Packs (RRPs), as well as external sources (e.g. Thomson Reuters) and public domain information. The information contained in the RRPs does not provide a sufficiently detailed breakdown of the actual costs to enable a precise comparison against the specific elements of the incentive target and this should be borne in mind when reviewing the results/analysis .

1.2 Current incentive arrangements

The actual costs of shrinkage procurement are a pass-through revenue item, and there is a linked, limited, revenue adjustment related to performance against targets that can increase or decrease the effective recoverable costs from shrinkage by up to £7m.

The current incentive is designed around a performance measure compared to a target cost metric. It is intended to encourage an efficient procurement of gas and electricity associated with shrinkage energy; albeit the actual procurement activity is partly restricted by the Licence in that NGGT 'cannot speculate and are limited to procure shrinkage energy within certain timeframes'[3].

The target includes both:

- a target procurement cost (discussed in 1.2.1 below), which is intended to encourage efficient procurement of shrinkage energy; and
- target volumes (discussed in 1.2.2), which encourage NGGT to take actions to reduce CFU and CVS shrinkage volumes. Differences between out-turn volumes and the target volumes lead to adjustments to the target procurement cost.

These components feed into a target cost metric which also contains other items such as TNUoS and 'other system costs' (including EU-ETS allowances, DUOS and other costs).

The target cost metric is compared against the performance measure, which comprises the actual shrinkage costs and the revenues received by NGGT in respect of "Measurement Errors" and/or "meter errors" (both as defined in the Uniform Network Code)[4]. NGGT retains a 45% share of the difference between the target metric and the performance measure. Incentive payments are subject to a cap of £7m and a collar of £-7m, and the incentive runs annually.

1.2.1 Energy procurement cost incentive

The energy procurement cost element of the incentive mechanism is generated from:

- a forecast (gas/electricity) shrinkage volume for a calendar quarter multiplied by a 9-month average forward (gas/baseload electricity) price for that calendar quarter;
- a correction for the actual volume consumed multiplied by a proxy for a prompt product: a week-ahead average of a week-ahead price for the day of consumption (in gas using the 'working day next week' (WDNW) product, and for electricity using baseload for the week) ('prompt price proxy'); and

3 National Grid Gas Transmission December Business Plan, Annex A3.03

4 We have not reviewed this element of the incentive.

- an additional element to cover the 'swing cost allowance' (SCA) – which we understand is intended to account for within-year price movements[5].

The forecast volumes are required to be calculated and published by NGGT on a regular basis, based on a methodology that is also published by them[6]. The analysis is frequently audited (most recently in July 2019 by DNV GL[7]) and the methodology was reviewed in 2016 (when it was not vetoed by Ofgem[8]). The volumes are forecasted thus:

1. CFU volume targets (or 'baselines') are generated (once a year) by reference to an exponential fit[9] of historical CFU to St. Fergus flows, and allocated to gas and electricity on a quarterly basis based on historical quarterly ratios; and
2. UAG and CVS volumes are calculated quarterly for the next quarter as a simple average of 150 days' actual history.

Because actual shrinkage volumes are uncertain the cost target is adjusted for differences in actual to forecast requirements. This aspect of the incentive provides some drive towards more efficient procurement of forecast volumes but does not provide any incentive on actual volumes. Efficiency on actual volumes are instead encouraged by the energy efficiency incentive, described below.

1.2.2 Energy efficiency incentive

The energy efficiency (or volume reduction) element of the incentive mechanism is against a target comprising two components – a measure of the efficient volume of CFU, and a measure of the efficient volume of CVS. The details of this element of the incentive are included in a methodology generated and published by NGGT[10].

For RIIO-T1 CFU efficiency is calculated by reference to a model that relates annual CFU to annual average flows at the St. Fergus terminal. The model consists of an exponential curve fitted to historical observations.

If the actual CFU is outside a tolerance band[11] around the (ex-post) modelled expectation[12], then the target cost metric is adjusted by the amount above or below the band multiplied by the weighted average gas price used to calculate the cost target.

CVS efficiency is calculated by reference to a band defined by:

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5 See the discussion starting at page 22 of NGGT, "National Grid Gas (NTS) System Operator Incentives for 1 April 2012 Initial Consultation", July 2011 ("NGGT SO consultation, 2011") https://www.nationalgridgas.com/document/68386/download

6 For example, https://www.nationalgridgas.com/document/127691/download

7 https://www.nationalgridgas.com/document/128036/download

8 https://www.ofgem.gov.uk/system/files/docs/2016/05/shrinkage_incentive_methodology_statement.pdf

9 The exponential model was discussed in NGGT SO consultation 2011, at page 14.

10 https://www.nationalgridgas.com/about-us/system-operator-incentives/nts-shrinkage

11 The tolerance band is defined by the averages of the positive and negative residuals of the exponential model of historical observations

12 The actual annual St. Fergus flows are input into the model to generate the ex-post CFU target.

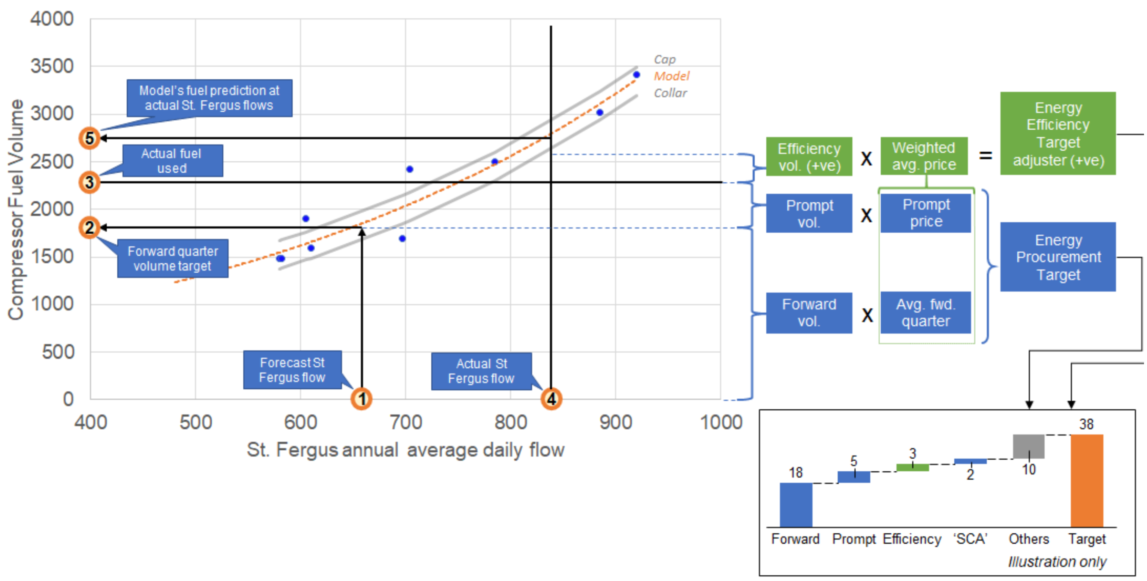
1. the average of the last three years' (Y-1 to Y-4) CVS performance (in annual terms); and
2. the prior last three years' CVS (Y-2 to Y-4) performance (in annual terms).

The band is defined as the maximum and minimum of these, i.e. the upper level of the band is the maximum of (1) and (2), and the lower level of the band is the minimum of (1) and (2). If CVS is outside the applicable band, then the target shrinkage cost is adjusted by the amount above or below the band and multiplied by the weighted average gas price used to calculate the target. As the CVS element of the energy efficiency incentive is small (CVS represents ~1% of shrinkage costs), we have focussed our analysis on the CFU element.

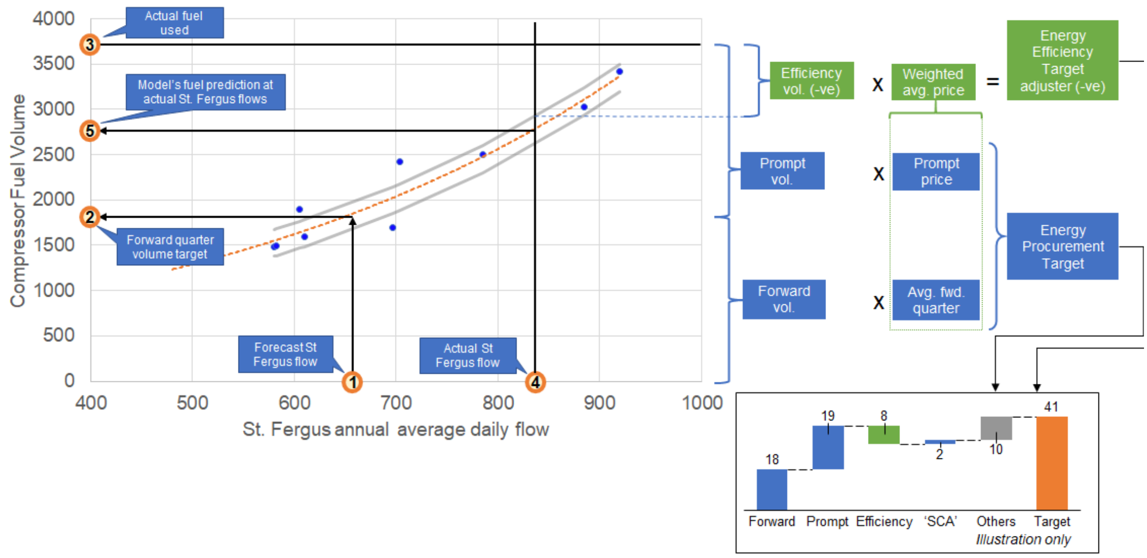
The operation of the energy efficiency incentive in respect of CFU and within the incentive target is visually described in Figure 2 below.

Figure 2 – Current shrinkage incentive target concepts (CFU)

Energy efficiency (volume) target outperformance



Energy efficiency (volume) target underperformance



Note: TNUoS is included in 'Others', alongside other components.

Referring to Figure 2, the operation of the incentive target in respect of CFU can be explained as follows.

- Based on annual forecast flows at St. Fergus (1), an annual forecast CFU requirement is created (2), which is pro-rated to individual quarters and each quarter's volume is multiplied by the relevant 9-month average forward quarter price. This forms the forward element of the energy procurement cost target.

- The difference between the forward volume forecast (2) and the actual CFU volume (3), is multiplied by the relevant prompt price proxy and forms another part of the energy procurement cost target.
- To calculate the adjustment for energy efficiency, the actual St. Fergus flow (4) is used to provide an ex-post forecast of total CFU volume required (5). A tolerance is applied to this, to form a cap and collar. Any difference between the actual CFU volume and the collar (outperformance), or the cap (underperformance) is then multiplied by the weighted average price used in the energy procurement cost target. This forms the energy efficiency target adjustment component.
- The SCA and other components (including TNUoS, etc.) are then added to form the target.

2. INCENTIVE REVIEW

2.1 Performance under RIIO-T1

2.1.1 Incentive revenues

NGGT has consistently outperformed the incentive, with the cost performance measure consistently being below the target. The incentive revenues received by NGGT are shown in Figure 3 below.

Figure 3 – [REDACTED]

[REDACTED]

[REDACTED].

2.1.2 Historical performance against target

This subsection examines the actual procurement costs and compares them against the implied cost target used to calculate the incentive.

Figure 4 and Table 1 below show the performance against target for both gas and electricity. The target combines elements associated with both gas and electricity (i.e. the energy efficiency target adjustment, and "other' costs"). In order to understand gas and electricity separately, we have apportioned these combined elements on the basis of the split of compressor fuel use, shown in the breakdown presented in Figure 5.

The target already includes the impact of the adjustments that arise because of actual consumption. Therefore, it is reflective of a weighted average price of procuring shrinkage using forward quarter products for forecast volumes, corrected for actual consumption by the prompt price proxy. The variance in costs (both target and performance) is driven by the combination of shrinkage volumes (shown in Figure 1 above) and market prices.

Table 1 highlights that the majority of the outperformance comes from the performance against the price element of the incentive.

We have proxied the allocation of combined elements between gas and electricity. On this basis, gas shrinkage costs represent on average 83% of the shrinkage costs over RIIO-1, with electricity shrinkage (i.e. electricity consumption associated with electrically driven compressors) accounting for the other 17%.

From initial observation the outperformance appears to broadly reflect the scale of the other cost elements in the target cost allowance. This may be spurious since we have been unable to reconcile how or where these costs are reported by NGGT in their cost reporting.

Figure 4 – [REDACTED]t

[REDACTED]

[REDACTED]

Table 1 – [REDACTED]

[REDACTED]

[REDACTED]

Figure 5 – [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

2.1.3 Procurement strategy performance

In order to assess benefits for consumers of the incentive, ideally we would want to compare the incentive payments to NGGT with the benefits to consumers of NGGT's change in behaviour under the scheme. However, the counterfactual for NGGT behaviour is hard to establish – the incentive assumes NGGT buy equal amounts of forecast volume over the period of trading of the product.

The majority of the outperformance has been against price and so we have looked at a range of synthetic bidding strategies to understand how well they would have performed against the constructed target. This analysis is presented in Annex A. From this analysis we observe that, as well as reducing the exposure to price risk, forward purchasing can have price benefits, though in the Annex we find that in practice these benefits have not been significant. The analysis indicates an estimate of the potential value-at-risk of a prompt-based strategy compared to a forward-based strategy of approximately £10m-£20m (though this is in extreme circumstances).

2.2 Review of incentive design

2.2.1 Swing cost allowance

Concept

In investigating the origins of the incentive design, we were unable to find a definitive explanation for the inclusion of a swing cost allowance. The System Operator External Incentive Plan (NGGT, May 2012)[13] justifies the inclusion of SCA on the basis that the incentive target assumes the procurement of a flat volume across the target period (i.e. forward quarters for both electricity and gas, forward week for electricity, forward WDNW for gas). In practice, actual consumption will vary within that (for gas, on a daily basis, for

[13] Available at https://www.nationalgrid.com/sites/default/files/documents/6255-Gas%20System%20Operator%20External%20Incentive%20Plan.pdf

electricity on an hourly basis). The SCA is intended to provide for additional costs of procuring shape.

We see limited justification for this. We note that the target already assumes that actual volumes, less the forward quarter target volume, are procured using a relatively prompt product (i.e. the WDNW product for gas & the week-ahead product for electricity).

Licence algebra

The current NGGT Licence algebra, Special Condition (SpC) 3D defines SCA for the period, t, in £m, as:

- 2 x RPIF(t)   where
  - RPIF(t) is the price index adjustment factor as derived in accordance with Part C of SpC 2A.

RPIF(t) is defined in Part D of SpC 2A, as the product of a ratio of RPI indices (a dimensionless factor) and two RPI growth rates (also dimensionless factors).

Regardless of the applicability of the SCA concept, we cannot reconcile this formulation as representative of the applicable cost premium.

NGGT proposals

NGGT's December Business Plan implicitly includes a proposal to continue the SCA, although the proposals do not:

- contain any detailed explanation:
- justification or rationale for including it;
- detail of how it should be defined; and
- specify the algebraic content.

2.2.2 Volume target methodology

The methodology to determine the volume targets (both for the energy procurement cost target and the energy efficiency measure) for the incentive is authored by NGGT, following the requirements set out in the licence.

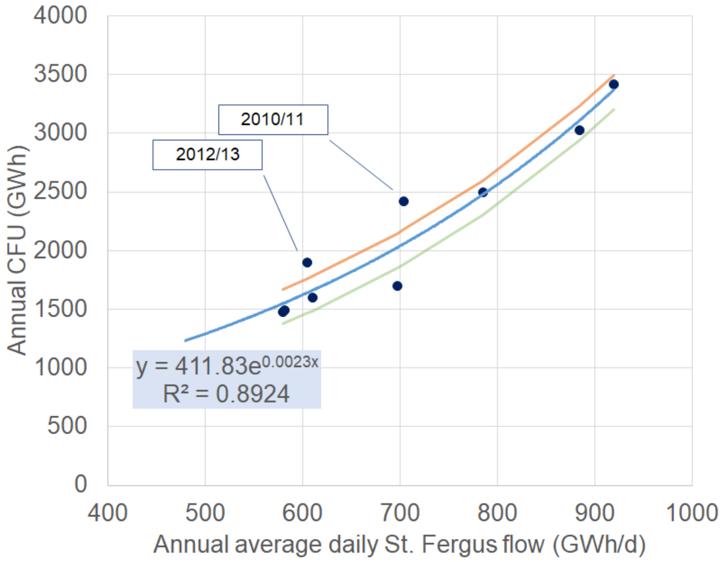
Because actual volumes consumed are taken into account in the weighted price element of the energy procurement cost target (as shown Figure 2), the methodology serves to set the balance between forward quarter and prompt prices in the cost target. 2.2.3.The other element of the methodology is to define the energy efficiency volume performance metric. The approach to CVS is described in section 1.2.2. Below, we explore the CFU approach in more detail.

CFU annual model

The CFU volumes are forecast (both for the procurement cost target and the energy efficiency element) by using a model of St. Fergus flows. We have not been asked to assess whether the continued use of St Fergus as the explanatory variable is correct (i.e. as flows through St Fergus reduce, do we start to see higher correlation between CFU volumes and flows at other entry points?) However we make the following observations, based on our review of other aspects of the incentive.

As shown in 1.2.2 and Figure 2 above, the methodology to determine the CFU energy efficiency target applies a tolerance band around the model to form a cap and a collar. The collar is represented by the green line in Figure 6, which shows an estimate of the model employed for forecasting consumption for the 2020/21 incentive year.

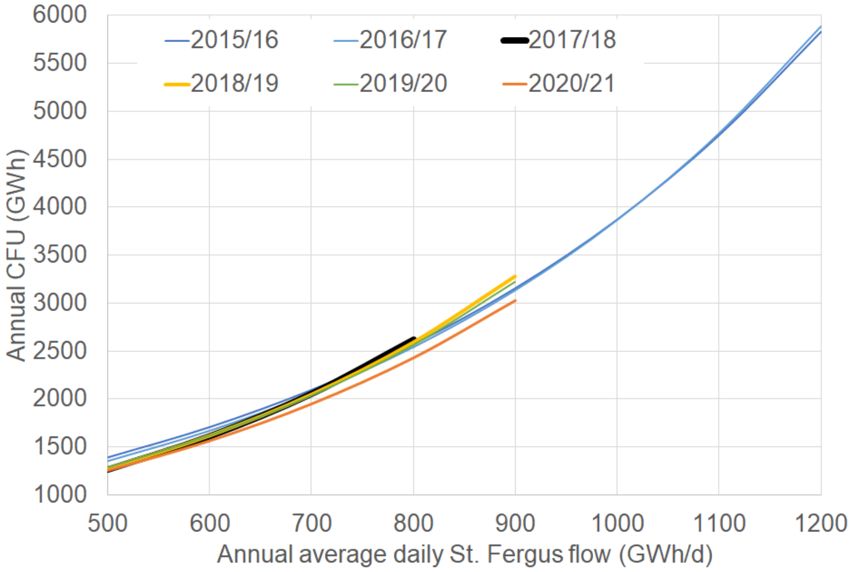
Figure 6 – Volume target model and dead-band (estimated)



Source: AFRY analysis. Data points estimated from https://www.nationalgridgas.com/document/124841/download

The model has been updated over time. The various models are shown in Figure 7. The review of the model, conducted in 2016, had the effect of removing earlier data points because of the lowered future expectations of St Fergus flows. This is indicated by the truncation of the 2017/18 model at the 800 GWh/d line. The actual St Fergus flows in 2017/18 went past the end of the model, resulting in the model being extended to 900 GWh/d in subsequent years.

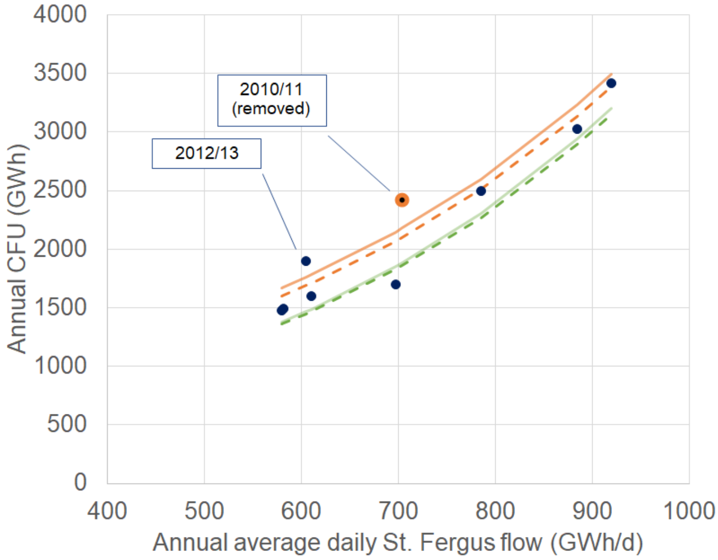
Figure 7 – Changes to volume target model over time



Source: AFRY analysis of various NGGT shrinkage publications:
https://www.nationalgridgas.com/about-us/system-operator-incentives/nts-shrinkage

Figure 6 also indicates that the model may need to be kept under regular review to avoid historical practices being overly weighted – the removal of the 2010/11 data point would shift the dead-band making it marginally harder to outperform but easier to underperform (exemplified in Figure 8 below – dotted lines represent the adjusted deadband with 2010/11 removed.)

Figure 8 – Effect of a potential model review



Source: AFRY analysis

CFU forecast disaggregation

Once the annual CFU target is calculated, this is allocated to calendar quarters, pro-rata, based on the actual CFU for the previous formula year's calendar quarters. It is then subsequently split between gas and electricity.

Observations on the CFU model

We make the following observations on the CFU forecasting approach.

1. The dead-band is absolute, not relative. This means that at higher St Fergus flows, there is a greater propensity for the out-turn CFU volumes to trigger the energy efficiency (volume) target adjustment.
2. It is unusual to use the mean of residuals as a mechanism for estimating uncertainty in model; it would be more usual to use other measures such as a confidence interval (i.e. percentiles) or measures of variance (e.g. standard deviation).
3. The exponential model is forecasting annual CFU, yet a forecast of quarterly CFU is needed to match to the products it is being used for. We would not, for example, expect St. Fergus flows to be a good indicator of CFU in the summer months, so the methodology may distort the incentive structure by systematically over- or under-forecasting.
4. The approach mixes the use of quarterly data from a single historical year to set the quarterly profile, with an annual forecast based on a series of years, which seems inconsistent.
5. The approach needs to be kept under regular review to ensure that changes in the use of the network (e.g. shifts in sources of supply) are captured and do not introduce distortions.

It is not clear to us that it would be possible to specify a model for CFU volumes at less than annual resolution.

In conclusion, recognising that the current approach is an approximation, addressing the issues identified would require a more complex and less transparent process, and may not deliver a robust model. The current methodology may create inaccuracies in the target that may lead to over-rewards for NGGT, however a more effective target may be too costly to develop for the additional value it would provide.

2.2.3 UAG volumes

Figure 9 shows some recent NGGT analysis of UAG volumes. The largely flat 30-day rolling average value indicates that UAG volumes can be relatively well forecasted over such a period, although note there is significant volatility at more granular resolution. However, we also note that NGGT describe UAG as "the consequence of data and or meter error"[14], and remain unconvinced that any reduction from prevailing volumes can be attributed to NGGT's concrete actions. We also note that there is a separate licence condition, Sp.C 8E, which requires NGGT to investigate and report on causes of UAG.

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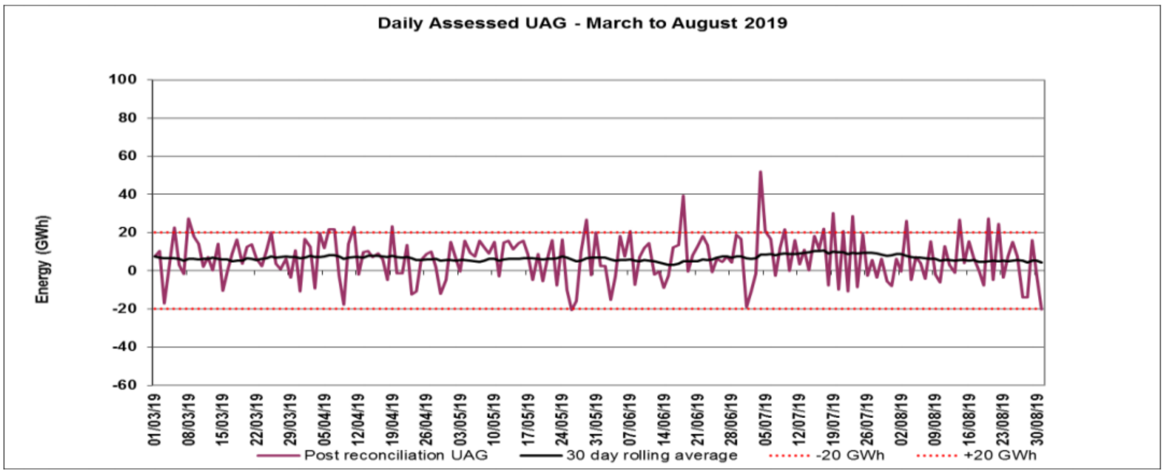
14 https://www.nationalgridgas.com/balancing/unaccounted-gas-uag

Figure 9 – UAG volume analysis



Source: NGGT, Unaccounted for Gas Report, October 2019

2.3 NGGT proposals for RIIO-2

NGGT responded to Ofgem's proposal for the shrinkage incentive in its December 2019 Business Plan Annex A3.03 'Output Delivery Incentives'. NGGT also set out its proposals for the shrinkage incentive in RIIO-2 in a Stakeholder Consultation on RIIO-2 incentives published in December 2019[15]. NGGT stated that it has direct control over the cost of energy procurement for energy shrinkage 'by determining the most appropriate time to enter the market to trade energy'. NGGT acknowledge that their control of the UAG and CVS volume components is restricted by potential errors in data and tolerance of existing meters.

We note that in the October 2019 unaccounted for gas report[16], NGGT states that the reason for the decrease in own gas use (i.e. CFU) in gas years 2016/17 and 2017/18 has been driven by a large drop in the supplies at the St Fergus terminal, as Liquefied Natural Gas (LNG) supplies increased. This suggests:

- that they have limited control over the volume element of the CFU component, which is instead driven by physical conditions of the network; and
- the methodology for forecasting CFU volumes with reference to St Fergus may be inadequate, especially as NGGT has limited control over volumes, but it might be possible to provide a better predictor of future volumes given the changing nature of the network.

NGGT's main proposal is to retain the fundamentals of the current scheme, where a financial output delivery incentive (ODI) incentivises NGGT to beat a target procurement cost. NGGT proposes to retain the allowances for TNUoS and for SCA, and to retain the three elements of CFU, UAG and CVS. NGGT also propose to add a price targets for seasonal products as, given the higher liquidity, seasonal products would provide lower costs compared to quarterly products. Finally NGGT propose to change the current cap and collar arrangement of +/-£7m to +/-£5m.

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15 https://www.nationalgrid.com/uk/gas-transmission/document/129251/download

16 https://www.nationalgridgas.com/document/128381/download

3. CONCLUSIONS

3.1.1 Complex design

The current incentive design is complicated and opaque. NGGT's proposals do not simplify the incentive design nor do they make it more transparent.

In respect of CFU, the forecast volumes required for both defining the volume of forward products in the incentive, and for defining a baseline of a volume-related performance measure, are reliant on a methodology that may be less representative of flows given the changing nature of network flow patterns and is therefore less reliable as the basis for an incentive target. The current methodology is questionable and has not been further justified in NGGT's December Business Plan.

Even though, in its Business Plan NGGT, propose that 'the shrinkage methodology is reviewed/consulted upon with stakeholders to agree the best available mechanism to set robust and visible target volumes', it is difficult to see how an appropriate and transparent methodology could be defined to generate more accurate forecasts of shrinkage volumes.

3.1.2 Consequences of removing CFU

The removal of the CFU element of this incentive would leave the incentive focussed on the efficient procurement of an inherently unpredictable volume of gas. It is difficult to see how this residual incentive would deliver any value.

Removing it would leave the incentive focussed on UAG and CVS. As volumes of UAG appear essentially unpredictable at daily resolution, it is not clear that the incentive does much to protect consumers from price risk. As CVS volumes are small, the incentive is of little consequence.

3.1.3 Consequences of relying on cash-out

Dispensing with the target and relying on cash-out (prompt) prices for UAG and CVS may expose consumers to additional price risk. However, as we discuss in 2.1.3, the value at risk is only estimated to be approximately £10m-£20m (including CFU) and would not be expected to materialise except under rare circumstances. In practice we would expect that without an incentive a prudent GSO would anyway consider hedging strategies as part of operating in an economic and efficient manner (see below).

3.1.4 Requirement to incentivise shrinkage procurement

Removing the financial incentive and dispensing of the target would not relinquish NGGT of the Gas Act obligations, "to develop and maintain an efficient and economical pipe-line system for the conveyance of gas". We would expect NGGT to seek to efficiently procure the energy required for running their network, even though it subsequently passes the costs associated with this through to consumers. As such, this should provide sufficient incentive for NGGT to make efforts to minimise expected procurement costs and associated risks – e.g. through forward procurement.

3.1.5 Requirement to incentivise shrinkage volumes

We note that the ability of NGGT to control the volumes of shrinkage is limited. UAG is (by definition) uncontrollable. Evidence suggests that NGGT has limited control of CFU, as set out in 2.3. CVS volumes are very small anyway and we do not see any reason why they should increase significantly.

Because it is not possible to predict what is a reasonable baseline or confirm the extent to which variation against a baseline/target is attributable to concrete actions by NGGT, we conclude that it may not be appropriate to financially incentivise volume reductions. Again, we would expect, to the extent possible, that NGGT's obligations under the Gas Act might provide sufficient incentive for them to reduce shrinkage volumes and procure those volumes that are necessary in an economic and efficient manner.

ANNEX A – SYNTHETIC STRATEGY ANALYSIS

The synthetic procurement strategies we have considered (as shown in Figure 10) include:

Perfect foresight strategy 1

This is calculated using the forward (FGVT[17]) and prompt (PGVT[8]) target volumes. The cost is generated by assuming the purchase of forward and prompt target volumes at the lowest price (either as quoted by Thomson Reuters or as reported by NGGT) during the forward and prompt periods respectively. Trading is limited to forward quarter and forward week (WDNW) products. In the case of negative prompt target volumes, the maximum price in the prompt (week-ahead) trading window was assumed to maximize the revenues from the sale of gas.

This strategy can be thought of as perfect price foresight (subject to product constraints), but with volume foresight constrained by the underlying methodology for calculating the incentive target (discussed in 2.2 above).

Perfect foresight strategy 2

This uses the *'Total Shrinkage, Assessed NTS'*[18] to determine the actual shrinkage volume on any given day. The total shrinkage volume was purchased at the minimum price seen across both the relevant forward and prompt periods. Trading is limited to forward quarter and forward week (WDNW) products. In the case of a negative shrinkage value the maximum price across both the relevant forward and prompt periods was used to sell the excess gas back in the market.

This strategy employs perfect foresight of both prices and volumes.

SAP based on-the-day (OTD)

This uses the *'Total Shrinkage, Assessed NTS'* and *'SAP, Actual Day'*[18] prices to calculate the daily shrinkage cost. This represents the outturn cost that might be expected if no forward trading (hedging) strategy had been implemented. We note that a simple comparison of actual cost against an OTD strategy does not provide a measure of the success of the actual strategy, because it neglects to consider that an exposure to OTD price risk has been avoided.

The analysis is imperfect because:

1. the strategies are applied ex-post and based on perfect foresight of prices – this is not a realistic proposition; and
2. the costs indicated by the strategies only partially include items which are included in the incentive target (i.e. 'Swing Cost Allowance' and 'Other Costs'), so the costs may be understated.

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17 Algebra terms in NGGT's GT licence.

18 http://mip-prod-web.azurewebsites.net/DataItemExplorer/Index

Figure 10 – [REDACTED]

[REDACTED]

[REDACTED]

The observations we draw from this are as follows.

- The perfect foresight strategies typically beat the SAP-based-OTD strategy, indicating
  - that there is a value at risk associated with a prompt-only purchasing strategy; and
  - forward purchasing can have price benefits.
- The impact from the extreme weather events of late Feb/early March 2018 (the "Beast from the East") that led to very high prompt prices (54p/th day-ahead; 194p/th within-day, 1 March 2018) can be observed in the 2017-2018 SAP-based-OTD data point. As this is widely recognised as an unexpected extreme event[19] with corresponding extreme prices, it begins to indicate the value-at-risk (approximately £10m-£20m) that the hedging strategies are protecting consumers from in the event of such rare circumstances.

19 National Grid Winter Review and Consultation, June 2018.

- "1 March was the seventh coldest day in our 58-year weather record history."
- "[1 March] gave rise to the highest gas demand experienced in seven years."
- "Demand in the distribution networks reached nearly 360 mcm. This was higher than the 1-in-20 peak forecast that we published in our Gas Ten Year Statement."

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