



UAGCVS Report

MAY 2023



Executive Summary

This report provides a review of National Gas Transmission (NGT) Unaccounted for Gas (UAG) management since April 2013, the start of the RIIO-T1 price control, with particular emphasis on 1st October 2022 to 31st March 2023 inclusive, the period since the publication of the November 2022 UAGCVS report.

This report also contains our Calorific Value Shrinkage (CVS) statement with an overview of its possible causes. The publication of this report discharges NGT obligations under the Gas Transporter Licence Part J of Special Condition 5.6 (System operator external incentives, revenues and costs) – requirement to undertake work to investigate the causes of UAG and CVS.

The total assessed pre reconciled UAG quantity for the 1st October 2022 to 31st March 2023 period is less than the previous six-month period. Monthly assessed pre reconciled UAG however is greater than the long-term average (April 2013 to March 2023) for 5 of the last 6 months, which is in line with winter throughput behaviour. Metering error has impacted UAG trends over this formula year.

NGT continue to improve its understanding of the causes of UAG through the use of data visualisation tools and investigative projects.

CV Shrinkage has increased in the winter period of Formula Year 2022/23 when compared to the same months in the previous year. CV Capping has continued to contribute towards the increase which has predominately been witnessed in NE LDZ.

Continued support from meter owners has enabled NGT to obtain and review meter validation information for NTS entry and exit facilities. This data is being used to support the identification of causes of UAG, to enhance NGT's ability to detect meter error and to inform the preparation of future meter witnessing programmes.

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Unaccounted for Gas & Calorific Value Shrinkage Report – November 2022

Introduction

This report provides a review of NGT's UAG and CVS management.

The report provides information on assessed UAG quantities since April 2013, the start of the RIIO -T1 price control, with particular emphasis on 1st October to 31st March 2023 inclusive, the period since the publication of the November 2022 UAG report. It describes NGT's endeavours to undertake projects for the purposes of investigating the causes of UAG and CVS.

UAG, CVS and OUG (Own Use Gas) are the three components of NTS Shrinkage. Further information on the components of NTS Shrinkage can be found via the following link:

[NGT - UAG Management](#)

To compliment this report, NGT also provides a range of UAG related data including:

- previous UAG reports and UAGCVS reports
- daily data on the components of NTS Shrinkage

which are available on the National Gas Transmission website via the above link.

For additional information on the components of Shrinkage, please refer to the following link:

[NGT - Shrinkage](#)

The publication of this report and associated backing data discharges NGT's obligations under the Gas Transporter Licence Part J of Special Condition 5.6 (System operator external incentives, revenues and costs) - Requirement to undertake work to investigate the causes of UAG and CVS. Part J of Special Licence Condition 5.6 – requirement to undertake work to investigate the causes of UAG and CVS which is detailed in Appendix I of the report.

If you have any feedback or questions on this document, please contact NGT's Meter Assurance team via the following email address:

meterassurance@nationalgrid.com.

The Meter Assurance Team are part of the Energy Balancing team within NGT and are responsible for investigating the causes of and reporting upon UAG and CVS.

National Transmission System Unaccounted for Gas Trends

This section of the report provides information on assessed UAG quantities since April 2013, with particular emphasis on the period 1st October 2022 to 31st March 2023.

Unless stated otherwise, all UAG values are Pre-Reconciliation UAG. Pre-Reconciliation UAG is the value which is recorded after entry and exit closeout. This data shows the position prior to any reconciliations taking place.

Formula Years 2013/14 to 2022/23

Figure 1 provides the annual assessed UAG, OUG and CVS quantities for Formula Years 2013/14 to 2022/23. A Formula Year refers to the period from 1st April to 31st March of the following year.

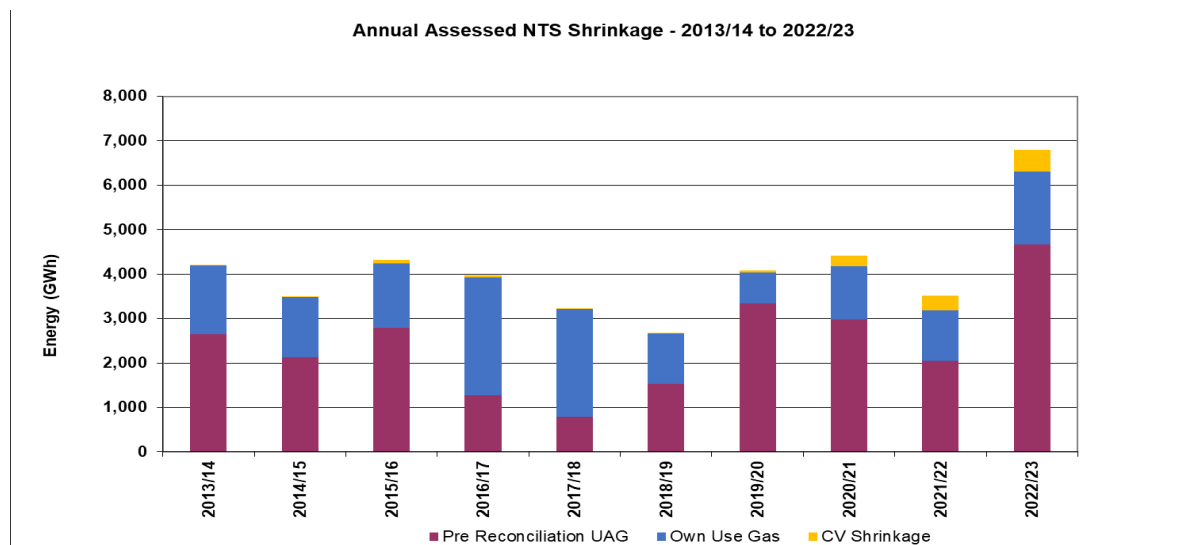


Figure 1: Annual assessed NTS Shrinkage – 2013/14 to 2022/23

Figure 1 demonstrates that for Formula Year 2022/23, NTS Shrinkage is higher than previous years. Known Distribution Network meter errors have significantly impacted UAG throughout these months, a large error at Thornton Curtis Offtake (EA LDZ) will be reconciled in due course and is expected to significantly reduce the levels of UAG reported here. UAG continues to be the predominant component, currently making up around 69% of NTS Shrinkage, OUG makes up 24% and CVS 7%. CVS became more prominent over the last few years and the potential causes of this will be explored in more detail later in the report.

Figure 2 provides the winter period assessed UAG, OUG and CVS comprising of October to March data for each Formula Year.

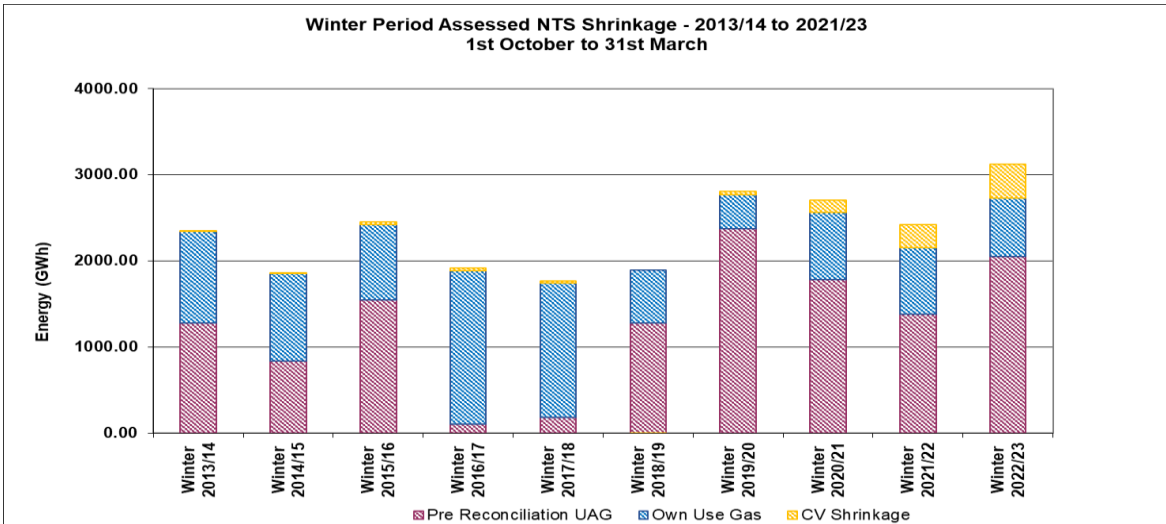


Figure 2: Winter Period Assessed NTS Shrinkage – 2013/14 to 2022/23

Figure 2 demonstrates that NTS Shrinkage throughout this winter period (October to March) has been higher than the previous periods. UAG has increased when compared to the previous winter but lower than 2019/20 although 2019/20 did include a large meter error that was reconciled. OUG has reduced slightly due to the configuration of flow this winter and reduced compressor usage. CVS has increased by 49% when compared to the last winter period.

UAG over this period equates to 2044 GWh, which is 48% higher than last year's winter period, although large meter errors were identified over the summer, there is still an expectation that there are further unidentified meter error(s) within the network.

There has been an increased number of high positive UAG days, which included 55 instances that exceeded the ± 20 GWh tolerance. A 17% decrease in the number of days where negative UAG was also observed when compared to the same period last year, therefore there was less netting off over this period.

Total OUG quantities have decreased by 13% when compared to the previous year's winter period.

CVS accounts for 13% of total Shrinkage and although the values for CVS are small in comparison to OUG and UAG, they have increased from previous years. Further information on CVS can be found in the CVS Statement within this report.

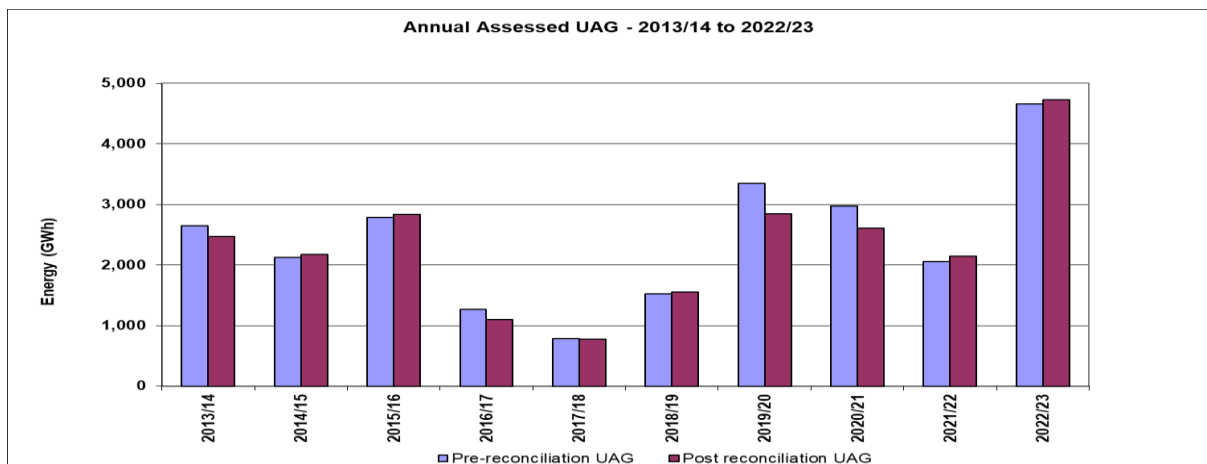


Figure 3: Annual assessed UAG – 2013/14 to 2022/23

Figure 3 represents both pre reconciliation and post reconciliation annual assessed UAG quantities for Formula Years 2013/14 to 2022/23. Pre reconciliation UAG is calculated using the energy measurements reported in the Gemini commercial system at closeout for the NTS entry and exit points. If a meter or data error is identified outside of entry and exit closeout for one of these points, the correct measurements are determined. Post reconciliation UAG is then calculated using the corrected measurements. The past two years reconciliations have slightly increased UAG although the large meter error that is due to be reconciled will significantly reduce Formula Year 2022/23. Further information on reconciliation is provided under section 'UAG Management Activities' of this report.

Table 1 provides the annual and daily average assessed UAG quantities for Formula Years 2013/14 to 2022/23. The table also provides the annual assessed UAG quantities as a percentage of annual NTS Throughput.

UAG	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
Assessed Level (GWh)	2,648	2,121	2,782	1,272	783	1,528	3,342	2,972	2,051	4,655
Assessed Daily Average (GWh/d)	7.25	5.81	7.60	3.48	2.14	4.19	9.13	8.14	5.62	16.32
Percentage of NTS Throughput	0.30	0.24	0.30	0.13	0.08	0.17	0.36	0.32	0.23	0.45

Table 1: Annual Statistical performance of UAG - 2013/14 to 2022/23

The values provided in Table 1 indicate that annual assessed UAG, assessed daily average UAG and percentage of annual throughput in 2022/23, are significantly higher than the previous years, with percentage of NTS throughput values being the highest seen across all Formula Years. Some of this increase is due to the known Distribution Network meter error but further investigation is required to determine any other possible causes of high UAG.

With the known large Distribution Network meter error identified in the 2022/23 summer period and further unknown errors over this Formula Year impacting UAG, the decreasing trend of UAG as a % of NTS Throughput that was witnessed since 2019/20 has now ceased.

As mentioned in the November 2022 UAGCVS Report, throughput increased over the summer period due to larger interconnector flows into Europe and an increase in throughput would also indicate a rise in UAG over this period, as UAG typically follows the rise and fall in throughput as seen in previous seasonal trends.

Figure 4 shows the total monthly assessed UAG from April 2013 to March 2023. It also provides the average monthly assessed UAG for this Formula Year (387.95 GWh) represented as the horizontal black line, together with the long-term average assessed UAG for the entire period (201.29 GWh) depicted as a dotted red line.

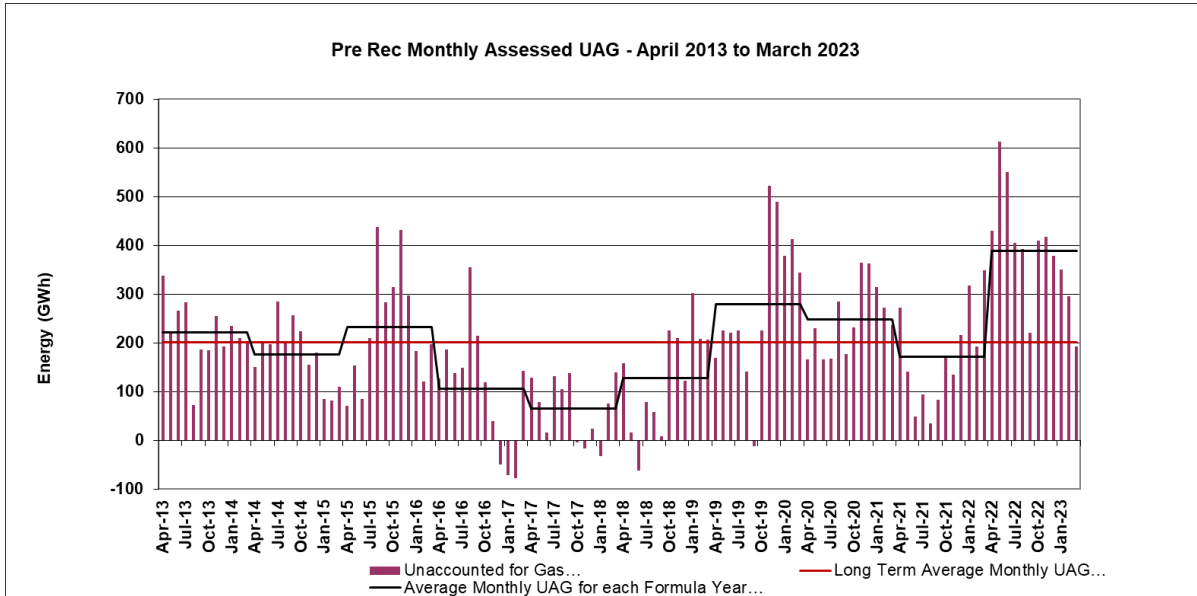


Figure 4: Monthly assessed UAG - April 2013 to March 2023

Throughout 2022/23, three months are above the Monthly Average (April, May & June) and 11 months are above the Long Term Monthly Average UAG.

Figure 5 provides the total monthly assessed UAG for October 2022 to March 2023, compared with the equivalent months within 2021/22. This highlights that UAG in October, November & December 2021 was unusually low for the winter period but also the same months in 2022 have been slightly higher than usual winter months.

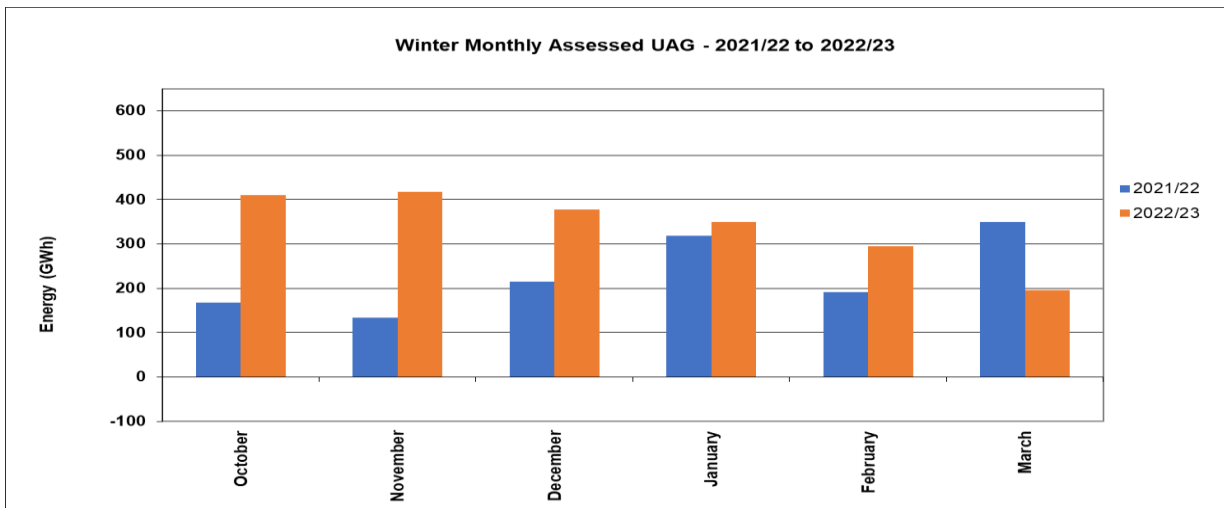


Figure 5: Winter Monthly Assessed UAG – October to March 2021/22 and October to March 2022/23

As seen in Figure 5 during the last six months the total monthly assessed UAG varied from +192.44 GWh to +418.01 GWh, with a monthly average of 340.69 GWh. These values are much higher when compared to the same months in the previous year (apart from March which is significantly lower). During October 2021 to March 2022, total monthly assessed UAG varied from +134.11 GWh to +349.08 GWh with a lower monthly average of 229.50 GWh.

Figure 6 shows the daily assessed UAG values for the period between 1st October 2022 and March 2023 and indicates that UAG has been outside ± 20 GWh for 30% of that time. Volatility between days has been observed and is depicted by a fluctuation of high positive to low negative or low negative to high positive UAG throughout the period. The rolling 30-day average indicates a potential meter error could have occurred over this period, in particular between mid-October to early January where a step change in the Rolling 30 Day average is witnessed.

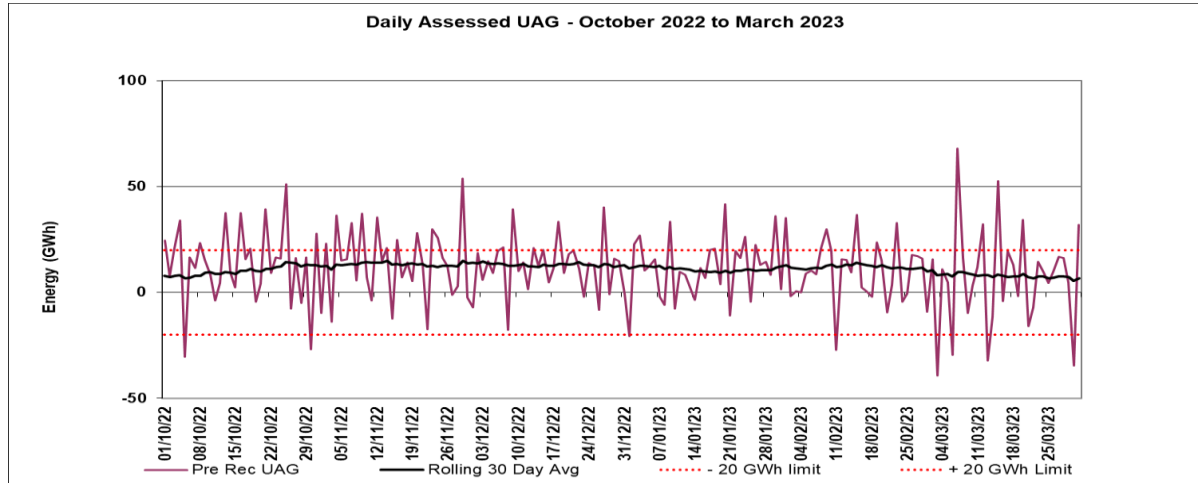


Figure 6: Winter Daily assessed UAG – October 2022 to March 2023

NGT reviews and investigates the assessed UAG values on a daily basis paying particular attention to any values that exceed ± 20 GWh. These baseline UAG quantities are provided as red dotted lines in the above figure. During the period of October 2022 to March 2023 there were 55 days when daily assessed UAG exceeded ± 20 GWh, 18 more days than the same period in 2021/22.

Whilst we have not yet quantified the causation of this UAG trend, NGT continues to work on identifying the source.

Figure 7 outlines the demand breakdown with UAG overlaid for the period between April 2018 to March 2023. Interconnector Export volumes have decreased by 31% since Summer 2022, although there is still a 60% rise in export flows when compared to the same winter 6 months in 2021/22. LDZ Offtakes continue to display a seasonal pattern throughout, whereas Industrial and Power Station demand demonstrates a more consistent annual offtake.

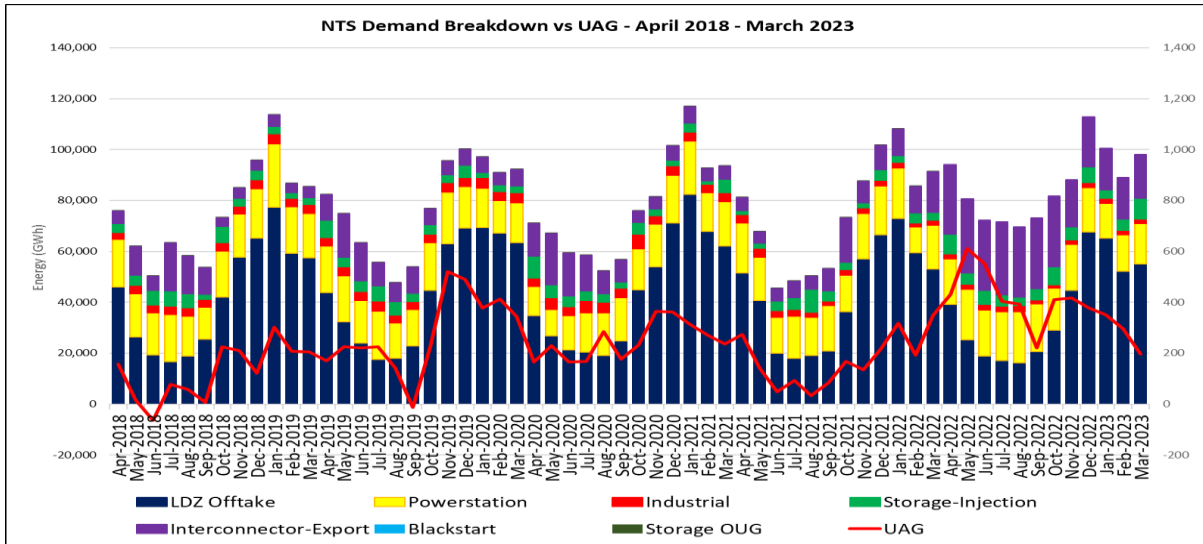


Figure 7: NTS demand breakdown – April 2018 to March 2023

Figure 8 below demonstrates the increases in monthly Interconnector Export volumes over the 2022/23 Formula Year although we have seen a decrease in these export flows since November 2022.

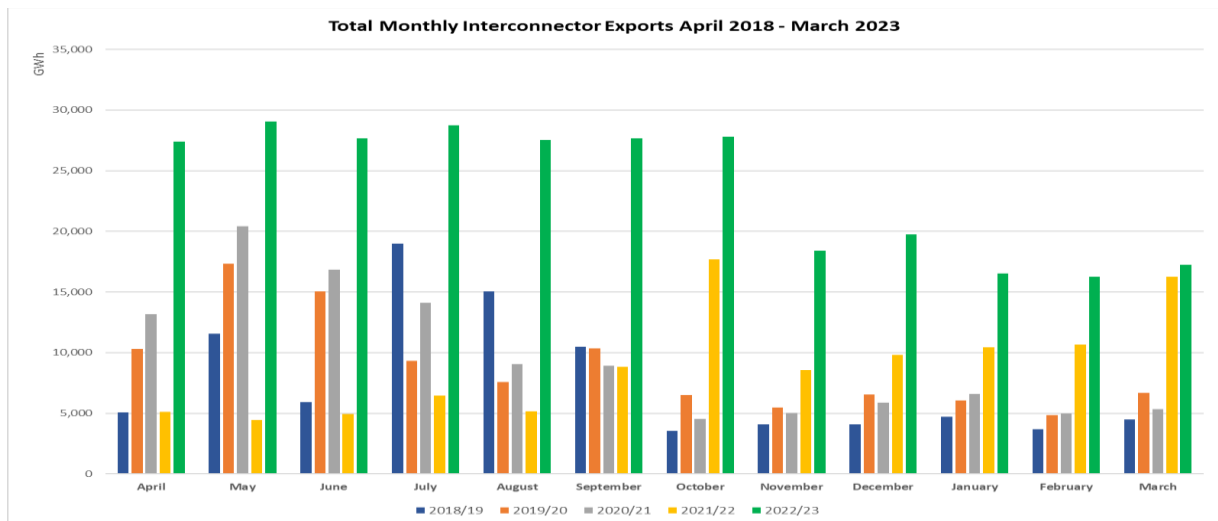


Figure 8: Interconnector Export April 2018 to March 2023

Figure 9 illustrates that Entry Terminals and LNG deliveries have continued with the seasonal patterns although increased LNG and Terminal flows were witnessed over the last summer period in line with the increased supplies to Europe. Likewise, Interconnector Imports have not been prominent in this Formula Year.

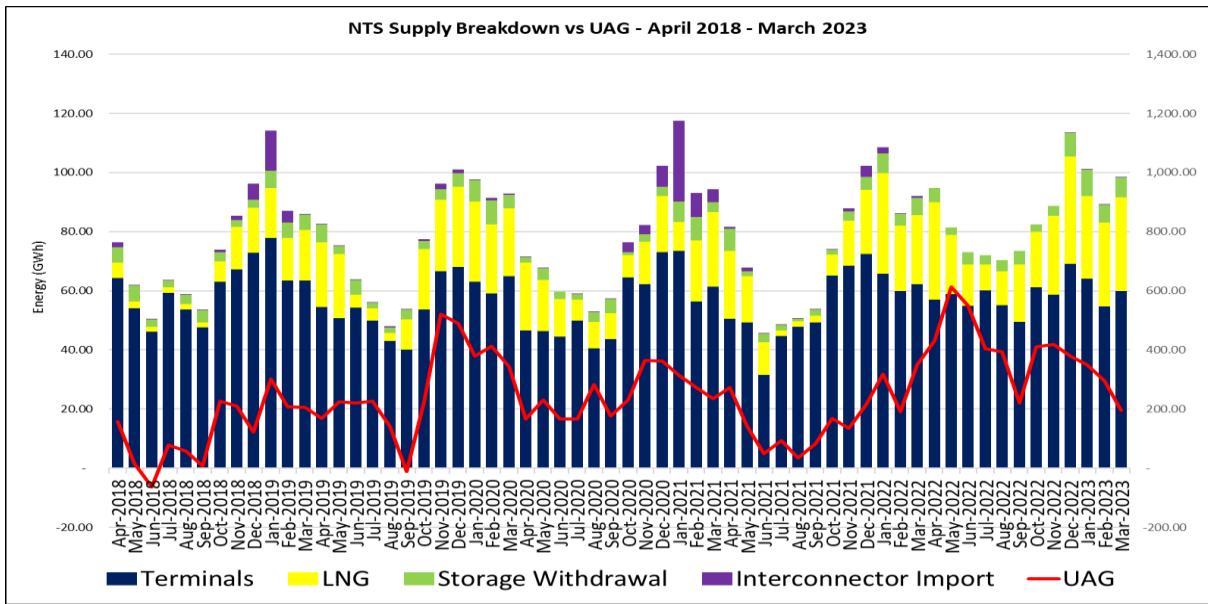


Figure 9: NTS supply breakdown – April 2018 to March 2023

Figure 10 provides the total LNG breakdown including South Hook and Dragon from Milford Haven in South Wales and both Isle of Grain Terminals in the South-East.

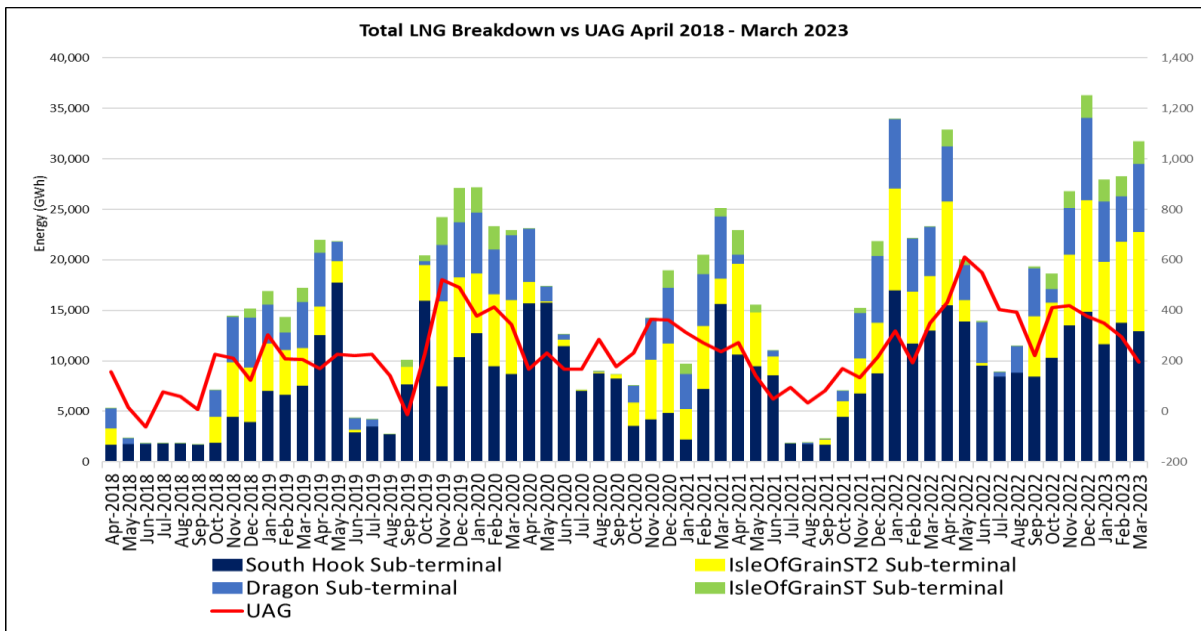


Figure 10: Total LNG breakdown – April 2018 to March 2023

As previously reported, UAG had increased and decreased with LNG flows but there has been no evidence to support that LNG flows are influencing this UAG behaviour. This winter period doesn't follow the fall in UAG as LNG has increased through this period.

Figure 11 below compares the total monthly LNG Imports since April 2018 and highlights the change in flow patterns that have been observed.

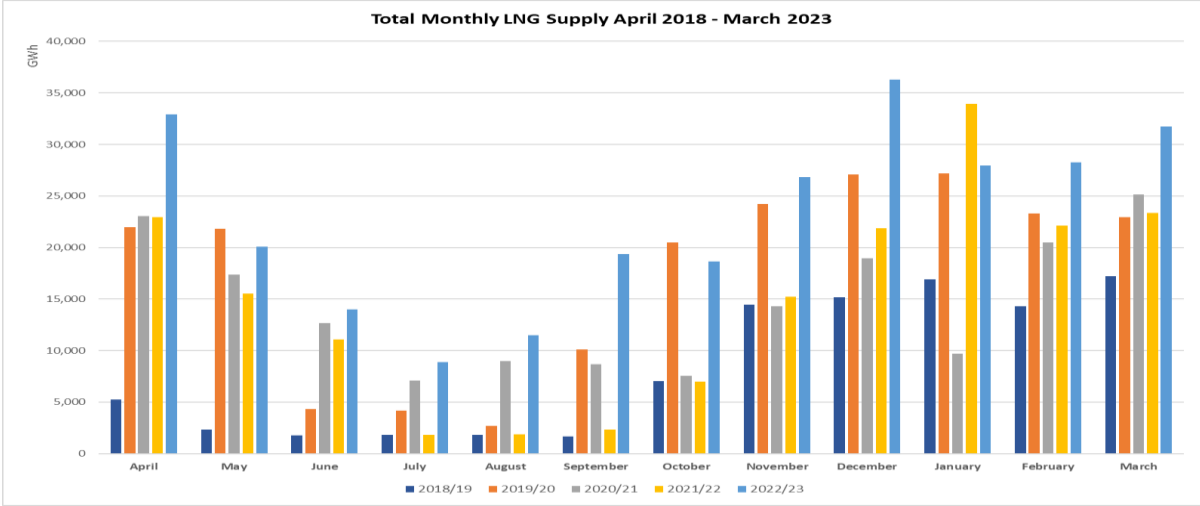


Figure 11: LNG Supply – April 2018 to March 2023

Figure 11 highlights that December 2022 had the greatest levels of LNG delivered onto the NTS, followed by January 2022. Over the last 6 months, we have seen larger LNG quantities in 4 of those months when compared to the same months over previous years although throughout the 2022/23 Formula Year, 10 months have seen the highest flows.

The relationship between UAG and LNG has previously been analysed and no significant correlation has been identified. The impact that gas temperatures have on volumetric measurements and UAG when delivered onto the NTS is being investigated. Progress of this investigation will be shared in future UAGCVS Reports.

Figure 12 displays the monthly net Interconnector position for BBL, Interconnector (UK) and Moffat over the period between April 2016 and March 2023. The positive values on the graph show the monthly net position being Interconnector gas imports and the negative values show the monthly net position value being Interconnector gas exports. This graph demonstrates that UAG has not previously followed a pattern to total net Interconnector activity, although in Formula Year 2022/23, UAG does show some reversed correlation to Net Interconnector throughput.

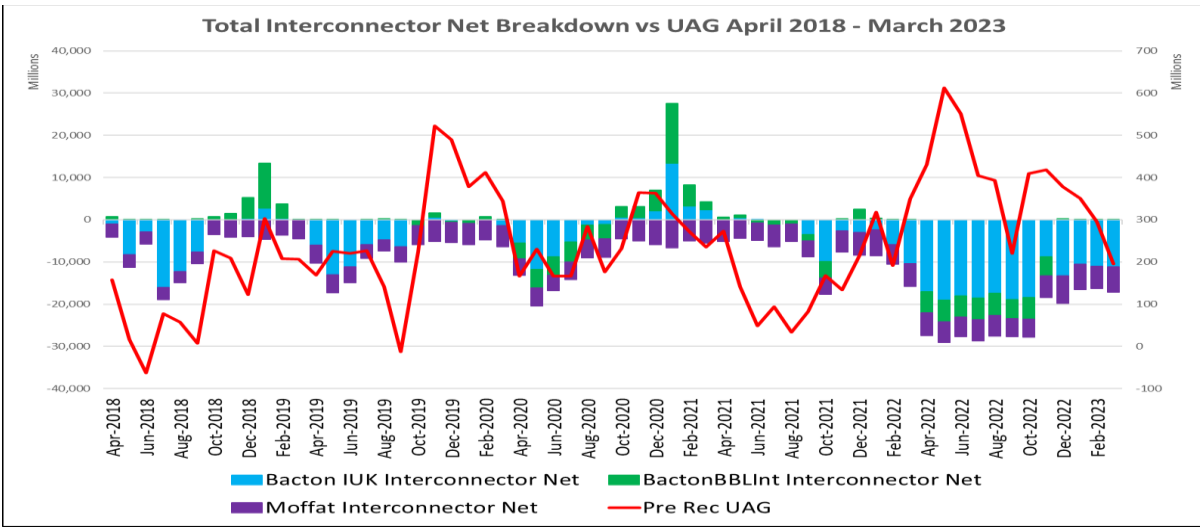


Figure 12: Net Interconnector – April 2016 to March 2023

Higher exports have been witnessed at Interconnector (UK) and BBL since April 2022, BBL have not exported gas since November and Interconnector (UK) also reduced their export flows by nearly half. Likewise, UAG has also reduced.

Meter Error is still deemed to be the main cause of UAG. As previously reported, significant meter error notifications were submitted to the Joint Office by Cadent following the identification of a large meter errors, 2 have been reconciled so far. One error at Alrewas EM NTS to LDZ Offtake impacted gas days between May 2019 to February 2021 and equated to 783 GWh. This error has decreased Post Reconciliation UAG over those impacted Formula Years. The other significant error reconciled, equating to 165 Gwh was identified at Royston NTS to LDZ Offtake (EM LDZ). This impacted gas days between October 2021 to October 2022 and increased Post Reconciliation UAG over the impacted Formula Years. Post Reconciliation UAG is shown below in Figure 13.

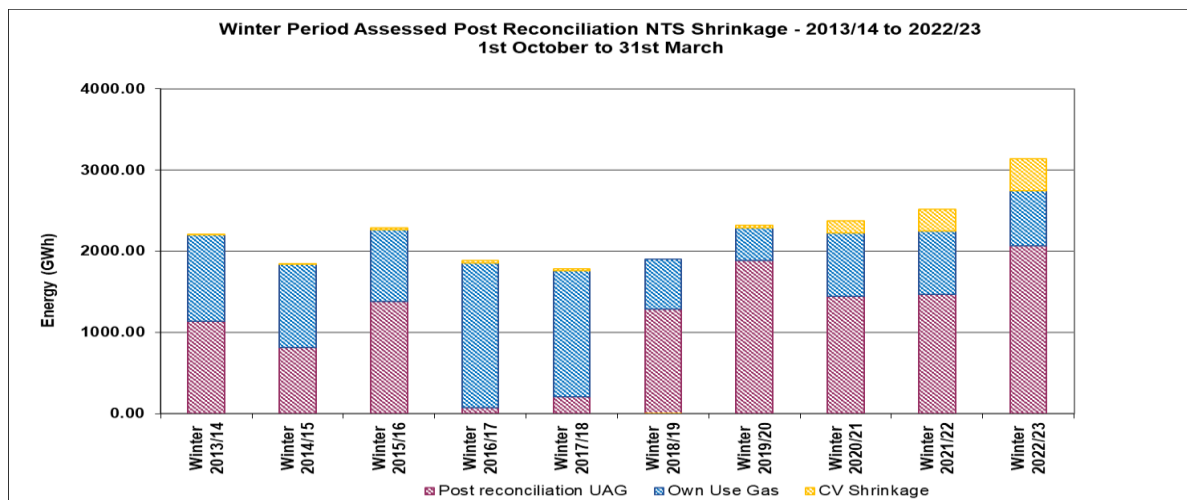


Figure 13: Post Reconciliation Winter Period Assessed NTS Shrinkage – 2013/14 to 2022/23

Corrected data has been used in Figure 13 to calculate a post reconciliation view of UAG. When compared to Figure 2, Post Reconciled UAG has been more stable since 2018/19.

A second significant meter error identified by Cadent at their Thornton Curtis Offtake is currently being analysed by two Independent Technical Experts (ITE's) to determine the magnitude of the error. The error impacts the gas days between April & July within the EM LDZ. A reconciliation will be issued upon the receipt of the ITE's Meter Error Report. The impact to UAG from this error will be conveyed in the forthcoming reports.

Formula Year 2022/23

This section of the report provides data on assessed UAG levels for the April 2022 to March 2023 period. This is the first opportunity for NGT to provide commentary on the full Formula Year.

2022/23	UAG	OUG	CVS	Total
Annual Assessed Levels (GWh)	4,655	1,648	491	6,795
Percentage of NTS Shrinkage	68.5	24.3	7.2	100

Table 2: Actual Assessed Levels for UAG, OUG and CVS – 2022/23

Table 2 provides the annual assessed levels of UAG, OUG and CVS for Formula year 2022/23. The table confirms that UAG was the predominant component of NTS Shrinkage which continues the trend seen in recent years.

Annual Assessed UAG has increased from the previous year by 127%.

The increase in UAG has been mainly attributed to a largely increased throughput throughout the summer period and a significant known meter error detected within that period. UAG exceed +20 GWh on 127 days throughout 2022/23 whereas 49 days exceeded this tolerance in 2021/22. Additionally, only 73 days saw negative UAG in 2022/23 whereas there were 111 days with negative UAG in 2021/22.

NGT have also observed a 55% increase in CVS compared to 2021/22 and an increase of 45% in annual assessed OUG.

Figure 14 below provides the total monthly assessed UAG for April 2022 to March 2023 compared to the equivalent months in 2021/22. During 2022/23, the total monthly assessed UAG varied from +192.44 GWh to +612.30 GWh with a monthly average of 387.95 GWh.

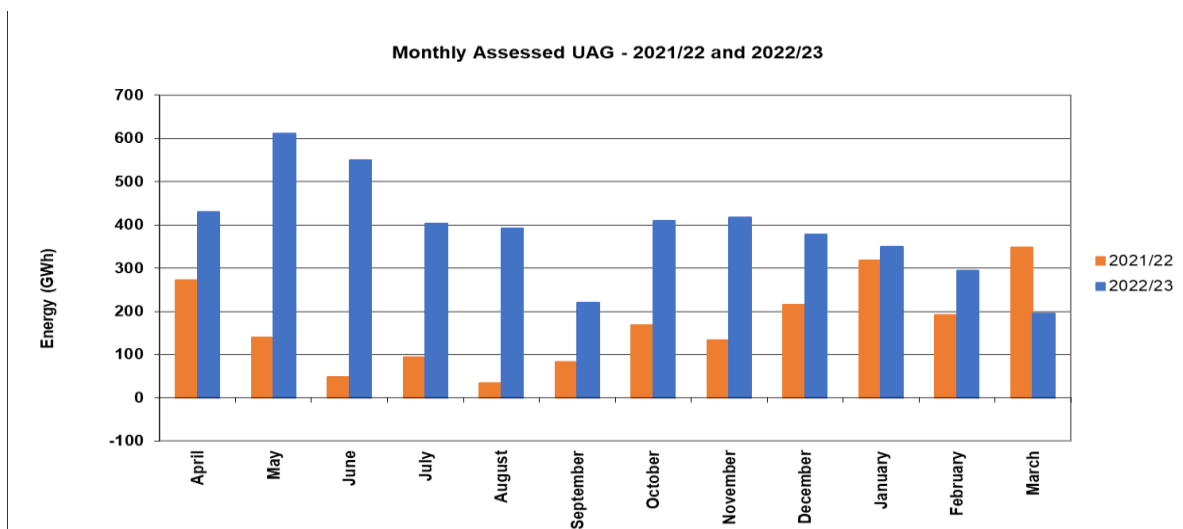


Figure 14: Monthly Assessed UAG 2021/22 to 2022/23

Figure 14 confirms the profile of monthly assessed UAG for 2022/23 is almost opposite to that in 2021/22. The profile is also not comparable to those observed in previous years, as seasonal patterns in this Formula Year have not been experienced where UAG increases during the winter months and decreasing during the summer months.

Figure 15 below provides the daily assessed UAG values between April 2022 and March 2023. Daily variability has continued to be observed with UAG varying from -39.44 GWh to +67.99 GWh and a daily average of 12.75 GWh, which has more than doubled the daily average for 2021/22.

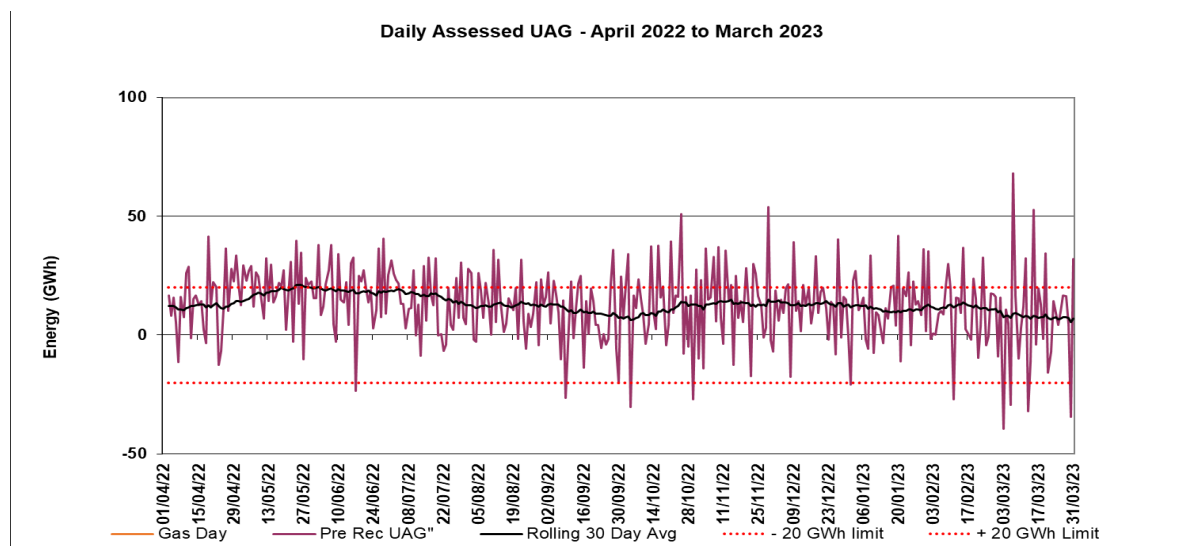


Figure 15: Daily UAG April 2022 to March 2023

The black line represents the rolling 30-day average, and the base line quantities are provided in the red dashed lines. An increase in daily UAG and variability during the winter months can be observed with the rolling 30-day average increasing throughout May to July, caused by the large known meter error at Thornton Curtis Offtake and again between October and February, cause still unknown.

During 2022/23 35% of the days exceeded ± 20 GWh, which saw a further 78 days over that tolerance than the previous year. 20% of days within the period were negative which is 38 days less than last year.

As described previously in this report, NGT reviews and investigates the assessed UAG on a daily basis, paying particular attention to any values that exceed ± 20 GWh. The Energy Balancing Team collaborate with stakeholders across NGT to investigate UAG trends, develop analytics and improve their understanding of UAG. UAG trends are a series of consistent patterns of UAG and are investigated through projects featured within this report.

UAG Management Activities

This section of the UAG report describes the various activities and initiatives that NGT has been undertaking or is planning to undertake to investigate the causes of UAG.

Meter Validation Report Reviews

Meter owners are obliged to undertake meter validations for each of their metering installations on at least an annual basis to confirm that the metering equipment is measuring correctly. The results of these tests are documented within a meter validation report and provided to NGT as soon as possible after the completion of the validation.

The validation reports provide essential information that allows NGT to assess the asset health and accuracy of the metering connected to its network. This enables a better understanding of the impact that meter error will have on assessed UAG.

For Formula Year 2022/23 NGT has so far received meter validation reports for 204 NTS entry and exit facilities, these reports are for validations that have taken place between April 2022 and March 2023.

From the validation reports that the Meter Assurance team have reviewed so far, NGT have raised queries where necessary with all relevant meter owners, to confirm if any instruments that tested outside of tolerance would have introduced measurement error, thus impacting assessed UAG levels.

The Meter Assurance team will continue to work with NTS Asset owners to review the Meter Validation Reports and close out any open actions that have arisen from the 2022/23 review period. The data provided and results recorded will be used to develop the meter witnessing programme for 2023/24.

During meter validation tests, the metering system is required to be intercepted in order to simulate and record values which entails disconnecting or overwriting physical instruments, wires and software. There is a risk that meter error could be introduced through these activities. NGT is continuing to investigate the potential to identify assessed UAG when meter validations are known to be taking place.

NGT is focussing on validation tests that have the potential to cause significant measurement error, to gain a better understanding of different calibration equipment and different tolerances. The asset owners are assisting with our queries associated to these tests.

Meter Witnessing

The purpose of witnessing the validations is to gain assurance that the measurement equipment within the metering installation continues to measure the gas delivered to or taken from the NTS without bias and within the agreed measurement uncertainties.

Witnessing involves NGT personnel attending metering installations throughout the UK during meter validations to observe and document the testing taking place. Since April 2022, NGT has witnessed numerous sites including an LNG Terminal, Interconnector, 3 Entry Terminals, a Storage facility and a Power Station. A witnessing programme for formula year 2023/24 will include sites that have either seen increased flows or have arisen from the meter validation results from this Formula Year. We will be engaging with NTS connected asset owners to arrange these visits in due course.

Reconciliation

NGT has an obligation to reconcile NTS related meter and data errors on behalf of the shipping community.

Over the last six months, since the publication of the November 2022 UAG Report, NGT has adjusted 195.78 GWh in absolute energy terms via the reconciliation process. This comprises of 16 instances of reconciliation at individual NTS entry and exit facilities, each instance comprising of one or more days of reconciliation for a total of 1029 gas days. Many of these reconciliations have been in Formula Year 2021/22 & 2022/23; however, reconciliations have also been processed for 2019/20 and 2020/21.

Figure 16 provides the annual reconciliation quantities, in absolute energy terms, for 2013/14 to 2022/23. The orange portion of the bars indicate the reconciliation quantities processed since the publication of the November 2022 UAG report.

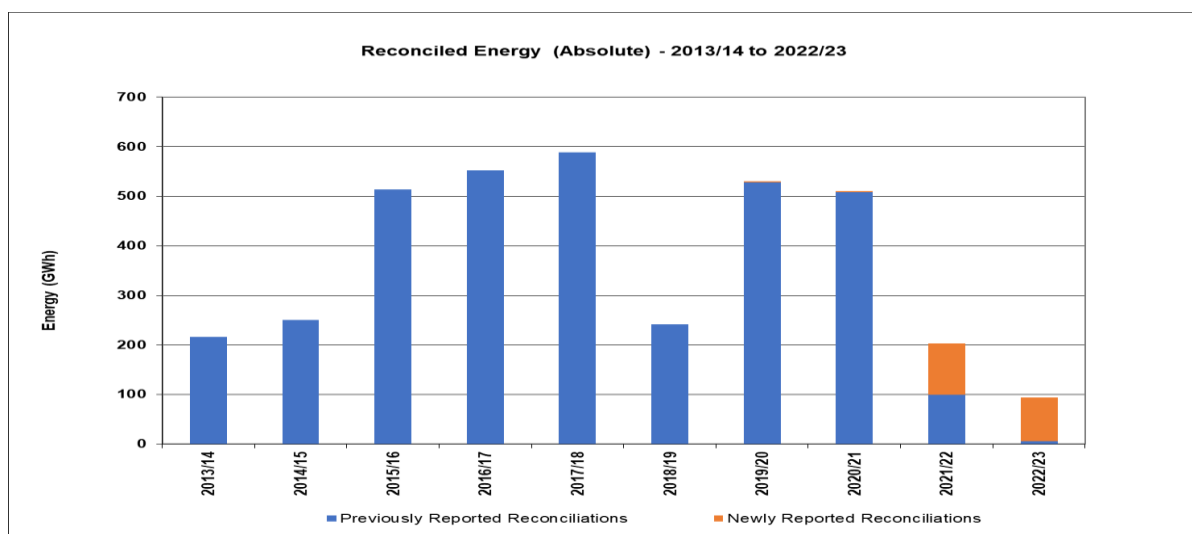


Figure 16: Reconciled energies (absolute) – 2013/14 to 2022/23

Of the 16 instances of reconciliation processed, 6 related to meter error and 10 related to data error.

A significant meter error identified at Thornton Curtis Offtake (EM LDZ) is yet to be reconciled but will impact the gas days between April 2022 to July 2022, this error is currently being investigated by two Independent Technical Experts (ITE's). Further information can be found on the Joint Office of Gas Transporters website [click here](#).

Reconciliation of this error will be carried out in due course after the ITE's have agreed the volume of error.

A further significant meter error that was identified at Royston Offtake (EA LDZ) equating to 164.4 GWh, has been reconciled impacting gas days between October 2021 and October 2022.

Figure 17 below shows absolute reconciled energy against Assessed UAG with that reconciled energy as a percentage of UAG. Reconciliation on average, is below 20% of UAG with the exception of Formula years between 2016 and 2018 where UAG was particularly low.

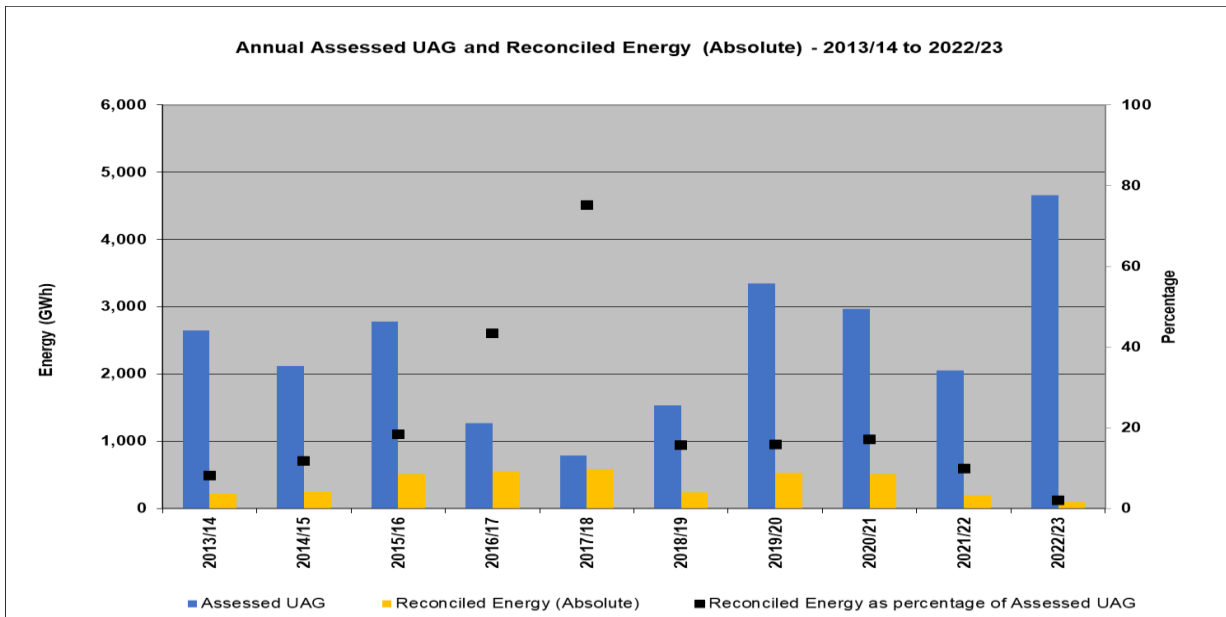


Figure 17: Annual Assessed UAG & Reconciled Energy (Absolute) – 2013/14 to 2022/23

Post reconciliation UAG has been applied to figure 118, this shows UAG between April 2019 to March 2022, align more to the values that were seen between 2013 & 2016. The Post Reconciliation UAG values in 2022/23 are expected to decrease significantly upon completion of the Thornton Curtis reconciliation but is expected to still be higher than seen throughout previous years.

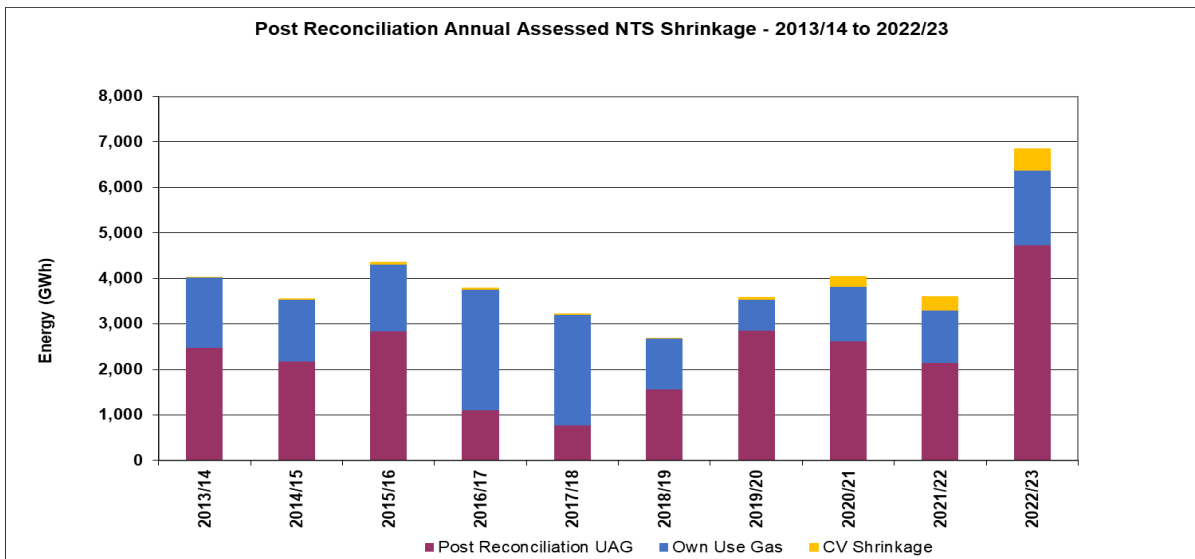


Figure 18: Post Reconciliation Annual Assessed NTS Shrinkage – 2013/14 to 2022/23

NGT is continuing to improve its validation of end of day measurements to help address data quality challenges experienced during the pre-closeout period. One initiative that has been offered to the Sub Terminals and Storage Facilities is the automated handling of their data into our systems, reducing the opportunity for manual input errors to occur. This is gradually being taken onboard by both Sub Terminals and Storage sites and NGT hopes that this can be rolled out to NTS entry sites in the future.

NGT is continuing to process meter and data error reconciliations which will be included in future reports.

UAG Investigation

NGT manage projects to investigate the causes of UAG, the increase of assessed UAG that has been observed since November 2019. These projects include historical and future UAG patterns or trends.

NGT's continued ambition is to better understand end to end data flows to identify and mitigate systematic data error, to automate and validate all data points and build the tools to identify the sources of UAG.

Since the publication of the May 2022 UAGCVS Report various projects have been undertaken to investigate the current trend in UAG that has been apparent since April 2022 which has helped to understand and ensure assurance in our data and by carrying out site elimination checks using flow profiles across all sites, we were able to rule out any obvious outliers.

The high trend between April and July 2022 will reduce once the significant reconciliation has been issued but we suspect that there are still other significant errors over this Formula Year attributing to this high UAG behaviour.

There have been multiple 'mini' projects specifically to look at the current high UAG trend. The following have been carried out since the November 2022 UAGCVS report and are additional to the projects scoped in Table 2 below.

A Triage Process that identifies the source of data anomalies.

End to end process maps have enabled a smoother internal process to raise, log and rectify issues that are meter or telemetry related.

Improvement of data visualisation tools to assess site profiles against UAG behaviour.

Visualisation tools that look at site flow profiles now also include UAG behaviours, therefore correlation of flows to UAG behaviour is now easier to detect. All sites have been checked across this Formula Year and so far, there haven't been any sites that stand out as causes for this UAG trend.

Review of current daily amendment methodologies to ensure accurate data.

A review of the daily settlement processes has started, this to ensure that current methodologies to carry out within closeout amendments are still the most effective. Further information will be shared in future reports.

Improvement to SCADA data calculations

SCADA calculations and telemetry methodologies have been reviewed, so-far the current process for deriving end of day average CV has been improved. Although this doesn't impact the end of day telemetered energy, it does impact the amendment and attribution process. Further projects in this area are still ongoing that will reduce the requirement for manual entry and potential data errors that could cause UAG and require reconciliation.

Duplicate data investigation.

Duplicate volume and energy data has been identified in some of the data we receive from 3rd parties, this is currently being identified, although this phenomenon precedes this UAG trend so is unlikely to be a cause. Further information will be shared in future reports.

Improvement of OUG data

Improvements to how NGT derives the energy values for Compressor Fuel Usage (Own Use Gas), which is an element of Shrinkage, has been introduced into daily processes.

Linepack Calculation Review.

A review of the calculation and the use of fixed Temperatures versus ground temperature identified some marginal bias in the Linepack model but as UAG uses a delta linepack, any differences seen on a day seem to net off over a period.

Other 'mini' projects that also feature in the November 2022 UAGCVS Report are detailed below:

Understanding UAG as a percentage of throughput. UAG as a percentage of throughput had increased in Q2 with a step change from 0.2% to 0.6% when comparing to Q2 in 2021.

Venting. Vented gas as a result of maintaining the NTS Network is calculated and provided to Meter Assurance as part of the NRO (Non-Routine Operation) guidelines. The vented volumes of gas calculated over this period were very small and not significant and therefore ruled out as a cause of the UAG trend.

NTS Maintenance. Maintenance dates and records were compared to UAG Trends to identify any correlation although there was no evidence of maintenance being a cause for the high UAG.

Site Elimination. Individual site profiles were analysed as well as looking for correlation between UAG and the number of sites flowing since 01/01/22. There were no obvious outliers from either of these investigations.

Interconnector & LNG Trends. Due to the higher volumes of gas seen at both LNG Terminals and the 2 Interconnection Points (IPs) at Bacton, it was prudent to compare UAG to historical periods when both LNG and IPs had large flows. As seen in Figures 15 and 16 below, there was some correlation observed with LNG when compared with UAG, which has been highlighted in previous reports but deeper dives into analysing the data at site level has not identified any error with the measurements. NGT continues to monitor these trends.

Project / Initiative	Target Completion Date	UAG / CVS	OUTCOME
Enhancements to UAG Causality detection models	Wider 2022/23 reporting period	UAG	Ongoing: This will roll over into 2022/23 whilst NGT resource necessary expertise.
Linepack calculation improvements	Wider 2022/23 reporting period	UAG	Closed: Although there is potential small bias within the Linepack Calculation due to fixed temperatures, the bias would be constant. UAG uses the Delta Linepack (diff between daily linepack) and the error nets off over time.
Continuous improvement / process improvement to the Settlements Process and ability to validate site Measurements within Entry and Exit Closeout	Wider 2022/23 reporting period	UAG	Closed: A review has been completed; daily checks are captured which feed the high UAG investigation process. Current tools and new requirements documented which will be supported by a new data platform. With new data models becoming available over time this review process will be ongoing with new projects arising from it each year. Therefore, further improvements to the process will roll out into the next reporting period.
Linepack Analysis using ground temperature	Wider 2022/23 reporting period	UAG	Closed: This project identified a potential small bias within the Linepack model but for UAG purposes, the magnitude of error would be negligible.
Consider impact of OBA on UAG calculation	Wider 2022/23 reporting period	UAG	Closed: Although OBA can impact Daily UAG, this nets off over a few days so therefore has no impact on UAG and Shrinkage.
Calculate UAG zonally across the NTS	Potential future project	UAG	On Hold: The possibilities of this have been discussed with Network modellers. Due to the amount of new data points required to do this, it would be out of scope for this reporting period. Cost benefit analysis will steer this as a future project.
Review of ± 20 GWh baseline tolerances	Wider 2022/23 reporting period	UAG	Ongoing: The current trend in UAG has been adequately captured within the current baseline. This will roll over into the following period, especially if the current behaviour changes or settles.
Investigate the impact of a lower Wobbe Index at NTS input terminals and how it could influence CVS	Wider 2022/23 reporting period	CVS	Closed: There is potential for a reduction in CV if Wobbe is reduced due to an increase in inert components. This could impact CV Shrinkage in areas of the Network where gas cannot be blended. NGT may need to work with GDNs if certain terminals are impacted.
LNG Gas Temperature – impact of temperature cooling as it leaves the Terminal. Scope would also include NTS compressors	Potential future project	UAG	Ongoing: This requires network modelling and expert determination to determine if there are impacts on volume within the Network.

Table 3: Project initiatives for Formula Year 2022/23

Table 3 provides an overview of the UAG projects and initiatives NGT have planned over this Formula Year (2022/23). Other 'mini projects' (listed above) have also been undertaken that focus over this year's high UAG trend.

Resource in the data science arena has been limited over the last 6 months due to other projects. The projects that are scoped in this section will be scheduled in the coming months dependent on resource availability.

CVS Statement & Investigation

Calorific Value Shrinkage (CVS) is gas which cannot be billed due to the application of Gas (Calculation of Thermal Energy) Regulations 1996 (amended 1997) and is the Local Distribution Zone (LDZ) energy difference between measured and billed Calorific Value (CV).

The regulations outline that the daily CV average for a given charging area is calculated by summing the product of the CV and volume for all supply inputs and dividing by the total volume of gas entering the charging area.

The maximum daily CV average for a charging area permitted by the regulations is equal to 1.0 MJ/m³ above the lowest measured daily CV of the supply inputs into that charging area, meaning if for any given day an input into a charging area has a CV outside of this range, a capped CV (lowest CV + 1MJ/m³) will be applied to the whole region for billing purposes. This is to protect customers who may live near this supply of lower quality of gas and prevent them overpaying for the gas they are receiving.

To calculate CVS, National Gas deducts the value that is used to bill downstream shippers based on the principles detailed above, from what was measured leaving the NTS by OFGEM approved equipment.

CVS occurs every day for all charging areas with more than one supply input into the region, this usually only equates to very small quantities if capping hasn't occurred and is a result of the charging area CV being rounded to one decimal place following its calculation. With CV capping being the major contributing factor to CVS, UNC Offtake Arrangement Document Section F 2.2 details that all parties cooperate with the view to avoid or minimise the amount of CVS each day.

With that in mind, if capping is caused by an NTS/LDZ offtake, National Gas will investigate, and where possible, minimise or avoid capping and will provide guidance to the Distribution Network Operator (DNO) to alter patterns of flow through the offtakes or alternatively look at solutions to alter flows within the NTS to improve blending of gases. If the capping is caused by a non-NTS connected asset that inputs gas into the LDZ, the DNO's will investigate the source and liaise with the relevant asset owner to avoid future instances.

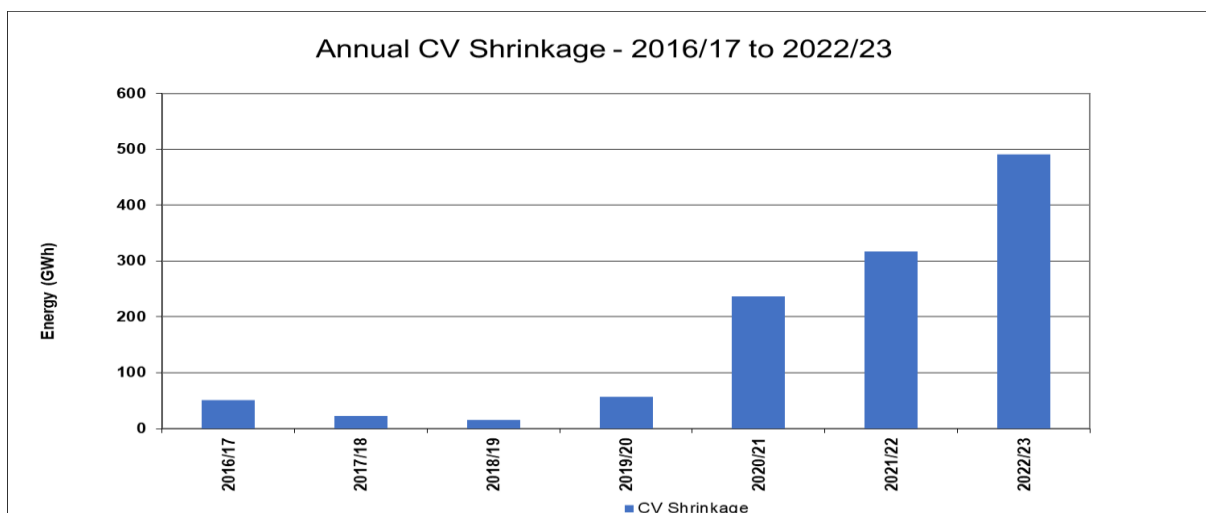


Figure 19 - Annual CV Shrinkage 2016/17 to 2022/23

Figure 19 provides a view of CV Shrinkage between 2016 and 2023. CV Shrinkage in 2022/23 has risen by 55% when compared to the previous year.

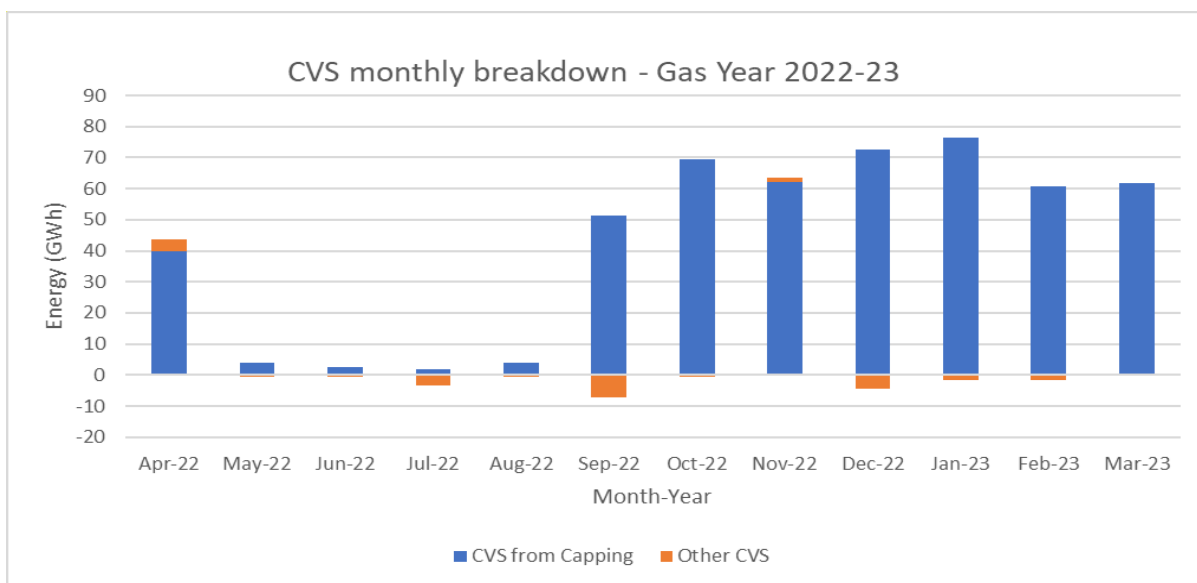


Figure 20 - CVS Monthly Breakdown 2022/23

Figure 20 provides a monthly breakdown of CV Shrinkage for 2022/23. This shows the proportion of CVS due to CV Capping detailed (in blue) and the remainder of other CVS (in orange), which can be either positive or negative when not caused by CV capping. This is due to the rounding of the LDZ CVS to 1 decimal place, as previously mentioned.

Throughout the last six months, CV capping has equated to 403.24 GWh with capping occurring in 9 of the 13 LDZs. The impacted LDZs are EM, NE, NO, NW, SC, SE, SW, SO, and WM with capping high throughout October to March as seen in Table 4.

For the year 2022/23, CV capping has equated to 507.03 GWh with capping occurring in 11 of the 13 LDZs, with only WN and WS having 0 GWh of capping.

Month	CVS caused by Capping (GWh)															Total
	EA	EM	NE	NO	NT	NW	SC	SE	SO	SW	WM	WN	WS			
Apr-22	0.00	0.00	22.64	8.40	0.00	5.06	0.00	0.00	0.00	3.80	0.00	0.00	0.00	0.00	39.91	
May-22	0.00	0.18	3.66	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.97	
Jun-22	0.00	0.00	0.81	0.91	0.00	0.00	0.18	0.00	0.00	0.00	0.78	0.00	0.00	0.00	2.68	
Jul-22	0.00	0.00	0.09	0.00	0.23	0.00	0.00	0.00	0.00	1.59	0.00	0.00	0.00	0.00	1.92	
Aug-22	0.00	2.03	0.32	0.54	0.00	0.89	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.89	
Sep-22	0.30	0.58	21.81	4.06	0.00	0.24	23.39	0.00	0.00	1.06	0.00	0.00	0.00	0.00	51.43	
Oct-22	0.00	0.00	11.36	1.32	0.00	0.34	54.95	0.00	0.00	1.49	0.00	0.00	0.00	0.00	69.46	
Nov-22	0.00	10.73	34.36	12.69	0.00	0.00	0.00	3.95	0.43	0.00	0.00	0.00	0.00	0.00	62.16	
Dec-22	0.00	0.00	55.32	9.97	0.00	0.00	7.15	0.00	0.00	0.00	0.19	0.00	0.00	0.00	72.63	
Jan-23	0.00	9.19	59.82	0.00	0.00	2.59	0.44	0.00	0.00	0.00	4.55	0.00	0.00	0.00	76.59	
Feb-23	0.00	5.78	47.65	3.57	0.00	0.00	0.00	0.00	0.00	0.00	3.68	0.00	0.00	0.00	60.69	
Mar-23	0.00	0.00	54.81	0.00	0.00	1.98	4.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	61.72	
Totals	0.30	28.48	312.66	41.45	0.23	11.24	91.13	3.96	0.43	7.94	9.21	0.00	0.00	0.00	507.03	

Table 4: CVS Caused by capping (GWh)

CV capping is most prevalent in NE and has increased by 32.4% from the previous year. Capping in the NE LDZ is mainly due to greater supplies of gas entering the region from the Teesside and Easington terminals. The gas entering the network at Teesside is typically a higher CV, where Easington typically has a lower CV. Due to the location of Paull Offtakes, which feeds gas into EM LDZ, along with the network configuration in that area, blending of the higher and lower CV gases cannot be achieved before it reaches that Offtake facility. Therefore, there is often a disparity within the CV's entering that LDZ, causing CV capping to occur. Of the 177 days between October 22 and March 23 that capped, 160 (90.4%) of the days were due to Paull Offtake receiving a lower CV to the remainder of the NE Offtakes, where blending of Teesside gas had increased the CV to a higher value.

Similarly, differences in CV values entering NO LDZ from St Fergus and Teesside terminals can impact CV capping although this hasn't been an issue since November 2022.

The Scottish (SC) region also has a large total caused by CV capping, but this seems to have settled since October 2022. This particular cause coincides with the handover of the FWACV process from NGT to Xoserve, where Biomethane data was not received from the DN's within the closeout period. Data transfer has improved since October and lower values of CV capping have been witnessed from November onwards.

Conclusion

Continued support from meter owners has enabled NGT to obtain and review meter validation information for NTS entry and exit facilities. This data is being used to support the identification of causes of UAG, to enhance NGT's ability to detect meter error and to inform the preparation of future meter witnessing programmes.

The total assessed pre reconciled UAG quantity for the 1st October 2022 to 31st March 2023 period is less than the previous six-month period. Monthly assessed pre reconciled UAG however is greater than the long-term average (April 2013 to March 2023) for 5 of the last 6 months, which is in line with winter throughput behaviour. Metering error has impacted UAG trends over this formula year.

NGT continue to improve its understanding of the causes of UAG through the use of data visualisation tools and investigative projects.

CV Shrinkage has increased in the winter period of Formula Year 2022/23 when compared to the same months in the previous year. CV Capping has continued to contribute towards the increase which has predominately been witnessed in NE LDZ.

Continued support from meter owners has enabled NGT to obtain and review meter validation information for NTS entry and exit facilities. This data is being used to support the identification of causes of UAG, to enhance NGT's ability to detect meter error and to inform the preparation of future meter witnessing programmes.

Part J: Requirement to undertake work to investigate the causes of UAG and CVS

5.6.53 The licensee must use reasonable endeavours to undertake UAG Projects and compile a CVS Statement for the purposes of investigating the causes of UAG and CVS for each Regulatory Year.

5.6.54 The licensee must, unless the Authority otherwise directs, publish the UAGCVS Reports and provide a copy to the Authority by 1 May and 1 November in each Regulatory Year for the preceding six month period ending on 31 March and 30 September respectively.

5.6.55 The licensee must outline in the UAGCVS Report:

- (a) the UAG Projects the licensee has undertaken in the previous period;
- (b) the UAG Projects the licensee proposes to undertake in the next period and its views on whether, and if so how, the findings of the UAG Projects may be taken forward in order to reduce the volume of UAG;
- (c) the reasons why any UAG Projects that the licensee proposed to undertake have not been undertaken during the Regulatory Year;
- (d) a CVS Statement outlining the work conducted during the previous period to investigate CVS, and explaining the licensee's understanding of the causes of CVS;
- (e) any additional activities and inspections undertaken by the licensee to improve metering calibration and accuracy;
- (f) a summary of any relevant discussions concerning UAG or CVS at industry fora and with interested parties on a one-to-one basis; and
- (g) any data or information related to UAG or CVS that the Authority may reasonably request.

5.6.56 During the period of 28 days beginning with the date of publication of a UAGCVS Report the licensee must, unless the Authority otherwise consents, publish on its website all the relevant data referred to in the UAGCVS Report.

Interpretation and definitions UAG

is unaccounted for gas and means the amount of gas (GWh) that remains unaccounted for after the Entry Close-out Date following the assessment of NTS Shrinkage performed in accordance with the Uniform Network Code. **UAG Projects** means the projects currently undertaken by the licensee including:

- (a) the witnessing by the licensee of the validation of Measurement Equipment at NTS System Entry Points or Supply Meter Installations at NTS Exit Points; and
- (b) investigation and analysis of data in order to seek to identify causes of UAG.

UAGCVS Report

means a report required under Part J of Special Condition 5.6 (System operator external incentives, revenues and costs).

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