UAGCVS Report

May 2022

Executive Summary

This report provides a review of National Grid Gas's (NGG) Unaccounted for Gas (UAG) management since April 2013, the start of the RIIO-T1 price control, with particular emphasis on 1st October 2021 to 31st March 2022 inclusive, the period since the publication of the November 2021 UAGCVS report. Additionally, the report provides an overview of UAG for the previous Formula Year as this is the earliest opportunity to do so.

This report also contains our Calorific Value Shrinkage (CVS) statement with an overview of its possible causes. The publication of this report discharges NGG 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 UAG quantity for the October 2021 to March 2022 period is greater than the previous six-month period. Monthly assessed UAG is also greater than the long-term average (April 2013 to March 2022) for 4 of the last 6 months, which is in line with increased throughput through the Winter period compared to the annual average.

NGG has continued to improve its understanding of the causes of UAG through the use of data visualisation tools and investigative projects.

CVS has increased in Formula Year 2021/22 when compared to the previous year. CV Capping has continued to contribute towards the increase which has predominately been witnessed in NO and NE LDZs.

Continued support from meter owners has enabled NGG 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 NGG's ability to detect meter error and to inform the preparation of future meter witnessing programmes.

Contents

Unaccounted for Gas & Calorific Value Shrinkage Report – May 2022

Introduction

This report provides a review of NGG'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 2022 inclusive, the period since the publication of the November 2021 UAG report. It describes NGG'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:

NGG - UAG Management

To compliment this report, NGG 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 NGG website via the above link.
For additional information on the components of Shrinkage, please refer to the following link:

NGG - Shrinkage

The publication of this report and associated backing data discharges NGG'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 NGG's Meter Assurance team via the following email address:
meterassurance@nationalgrid.com.

The Meter Assurance Team are part of the Energy Balancing team within NGG 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 2021 to 31st March 2022.

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 2021/22

Figure 1 provides the annual assessed UAG, OUG and CVS quantities for Formula Years 2013/14 to 2021/22. A Formula Year refers to the period from 1st April to 31st March of the following year.

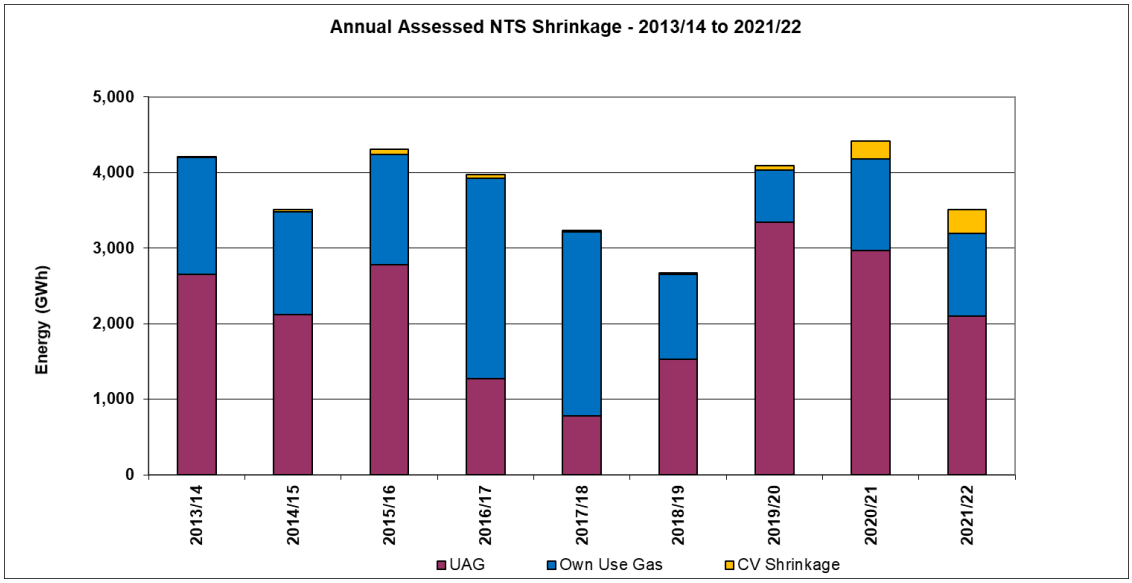

Figure 1: Annual assessed NTS Shrinkage – 2013/14 to 2021/22

Figure 1 demonstrates that for Formula Year 2021/22 NTS Shrinkage is lower than the previous two years and total NTS Shrinkage is similar to the volumes experienced in Formula Years 2014/15 and 2017/18. UAG continues to be the predominant component making up 58.5% of NTS Shrinkage which is a reduction of 9% from the previous year. OUG makes up 32.5% and CVS 9%. CVS has become more prominent over the last three 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.

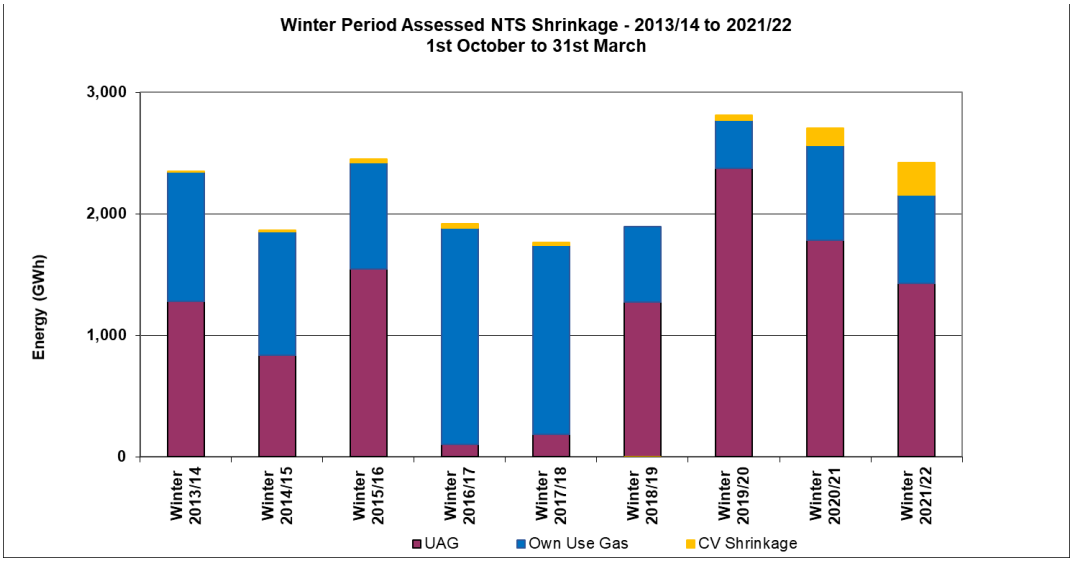

Figure 2: Winter Period Assessed NTS Shrinkage – 2013/14 to 2021/22

Figure 2 demonstrates that NTS Shrinkage throughout this winter period (October to March) has been lower than the two previous periods and has been decreasing year on year since 2019/20. UAG has also decreased throughout the last three years, although CVS has increased year on year. OUG has reduced in Winter 2021/22 having previously increased in Winter 2020/21.

UAG is 23% lower than last year's winter period with 37 instances that exceeded ±20 GWh, an increase of 43% in the number of days where UAG is negative has also been observed.

Total OUG quantities have also decreased in comparison to the previous year's winter period, with a reduction of 0.09% .

CVS is 83% greater than last year's winter period, although the values for CVS are small in comparison to OUG and UAG, further information on CVS can be found in the CVS Statement within this report.

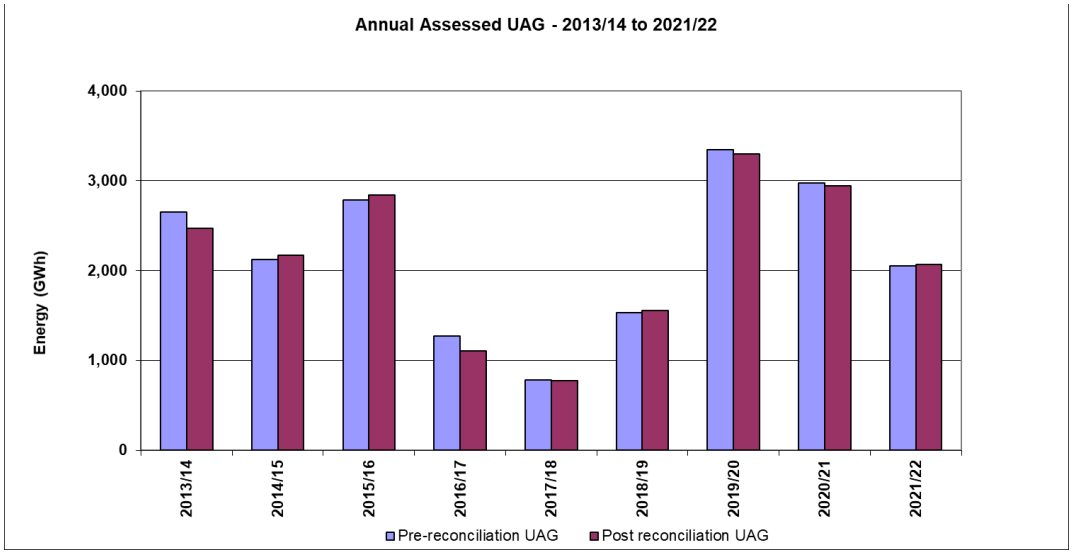

Figure 3: Annual assessed UAG – 2013/14 to 2021/22

Figure 3 represents both Pre-Reconciliation and Post-Reconciliation annual assessed UAG quantities for Formula Years 2013/14 to 2021/22. 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. Further information on reconciliation is provided under section 'UAG Management Activities' of this report.

During Formula Years between 2016/17 and 2018/19, more frequent periods of negative UAG were observed which reduced the net total of UAG for those years, as depicted by the blue line in Figure 4. The number of negative UAG days in Formula Year 2021/22 has increased by 37% when compared to 2020/21, and as expected, the net total of UAG decreased. The long-term annual average for number of negative days between 2013/14 to 2021/22 is 109 days. NGG will continue to investigate these periods of interest and will provide updates in future reports.

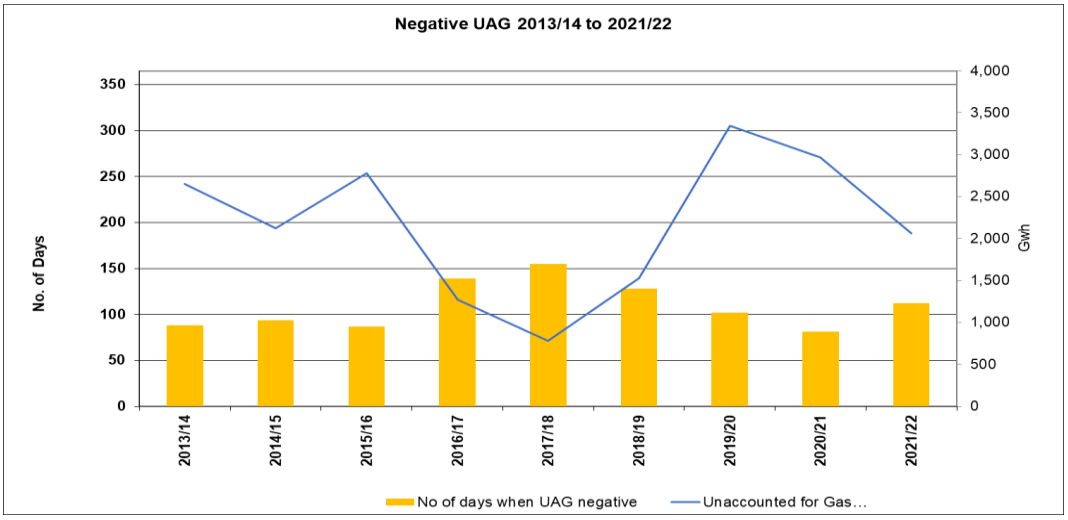

Figure 4: Negative UAG – 2013/14 to 2021/22

The increase in assessed UAG that was observed during 2019/20 and 2020/21 has been attributed to trends of consistently high positive UAG during the winter months. High UAG has also been present within 2021/22 but not to the same magnitude. The trends within 2019/20 and 2020/21 Formula Years have been investigated using data science and future analysis will continue for any other trends in UAG or periods of interest.

Table 1 provides the annual and daily average assessed UAG quantities for Formula Years 2013/14 to 2021/22. The table also provides the annual assessed UAG quantities as a percentage of annual NTS Throughput.

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

Table 1: Statistical performance of UAG - 2013/14 to 2021/22

The values provided in Table 1 indicate that annual assessed UAG, assessed daily average UAG and percentage of annual throughput in 2021/22 are lower than the previous year two years, with values more similar to those observed in Formula Year 2014/15.

The table highlights that UAG as a percentage of NTS Throughput follows Annual Assessed UAG and since 2019/20, when UAG equated to 0.36% of NTS Throughput, the following years' values have reduced. For 2021/22, UAG as a percentage of NTS Throughput is 0.23% which is 13% lower than Formula Year 2019/20 when the seasonal high UAG trend was first identified.

Figure 5 provides the total monthly assessed UAG from April 2013 to March 2022. It also provides the average monthly assessed UAG for this Formula Year (170.93 GWh) depicted as the horizonal black line, together with the long-term average assessed UAG for the entire period (180.55 GWh) depicted as a dotted red line.

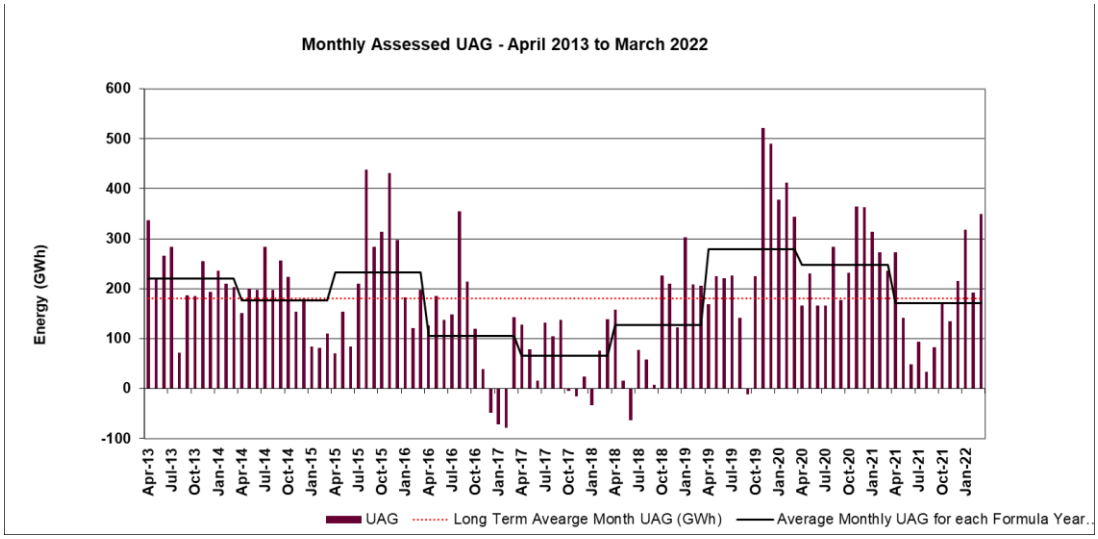

Figure 5: Monthly assessed UAG - April 2013 to March 2022

Throughout the 12 months within 2021/22, five are above the Monthly Average and the same five months are also above the Long Term Monthly Average UAG.

Figure 6 provides the total monthly assessed UAG for October 2021 to March 2022, compared with the equivalent months within 2020/21. This highlights that there has been a reduction in monthly assessed UAG in four of the last six months.

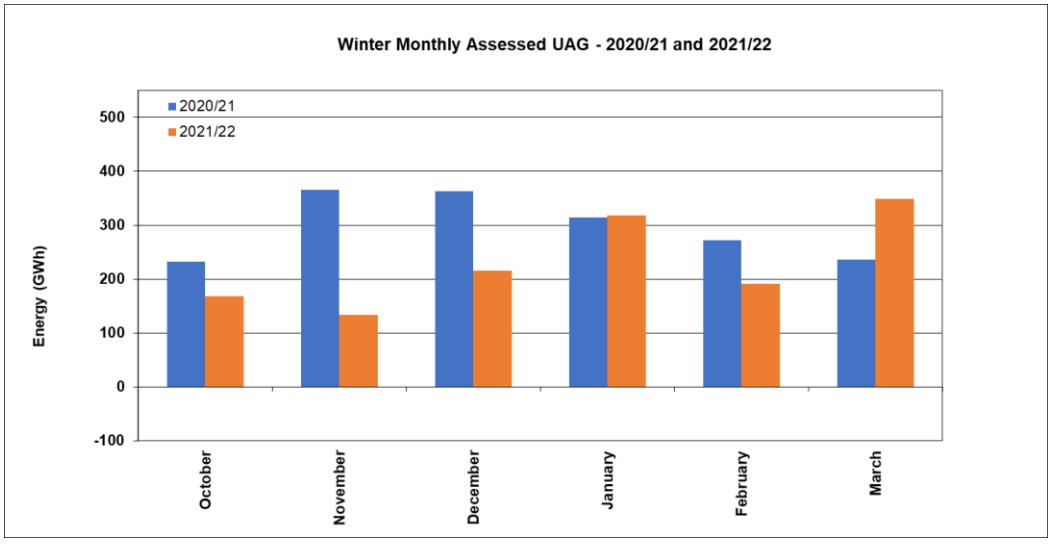

Figure 6: Winter Monthly Assessed UAG – October 2020 to March 2021 and October 2021 to March 2022

As seen in Figure 6, during the last six months the total monthly assessed UAG varied from +134.11 GWh to +349.08 GWh, with a monthly average of 229.50 GWh. These values are lower when compared to the same months in the previous year. During October 2020 to March 2021, total monthly assessed UAG varied from +231.50 GWh to +364.97 GWh with a higher monthly average of 296.78 GWh.

Figure 7 provides the daily assessed UAG values for the period between 1st October 2021 and March 2022 and indicates that UAG has been within ± 20 GWh for the majority of that period, with 20% of days exceeding the tolerance. 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 remains mostly flat and in a positive position throughout the period, with an average of 7.57 GWh/d. As previously mentioned, during the winter months over the last three Formula Years, increases in daily and monthly assessed UAG have been observed which have contributed towards a seasonal trend where UAG increases during the winter and decreases during the summer.

NGG 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 2021 to March 2022 there were 37 days when daily assessed UAG exceeded ± 20 GWh. This is a 12% decrease in high UAG days compared to the same period in 2020/21 when 42 days exceeded ± 20 GWh.

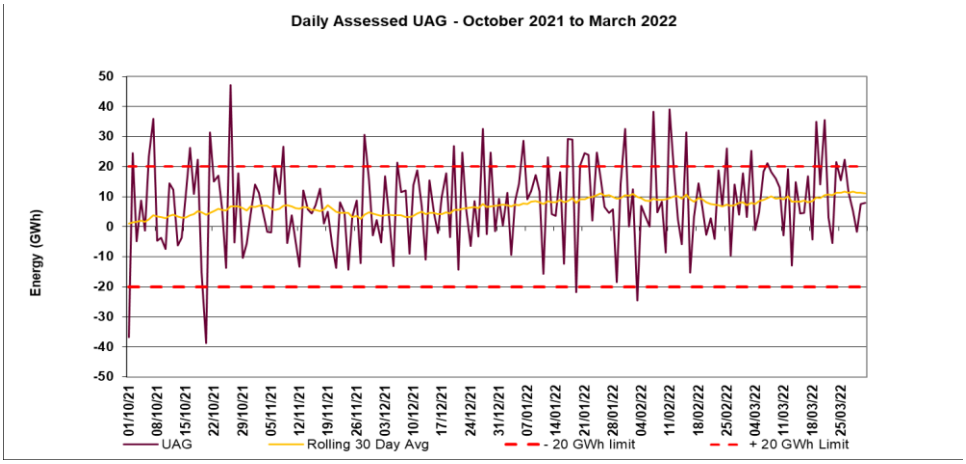

Figure 7: Summer Daily assessed UAG – October 2021 to March 2022

NGG have investigated all 49 days with high levels of positive or negative UAG that exceed ±20 GWh and have identified 2.5 GWh of UAG via the established High UAG Investigation Process. There are currently two open queries for gas days in March 2022 which could identify further UAG quantities. If they are successful the findings will be shared in a future UAGCVS Report.

Figure 8 outlines the demand breakdown with UAG overlaid for the period between April 2018 to March 2022. A change in the Interconnector Export volumes has been observed, which increased by 289% in October 2021 when compared to the same month in 2020. Additionally, total monthly Interconnector Export volumes from October 2021 to March 2022 have also exceeded the volumes observed for the same months within 2020/21. LDZ Offtakes display a seasonal pattern throughout, as does Interconnector Export, whereas Industrial and Power Station demand demonstrates a more consistent annual offtake.

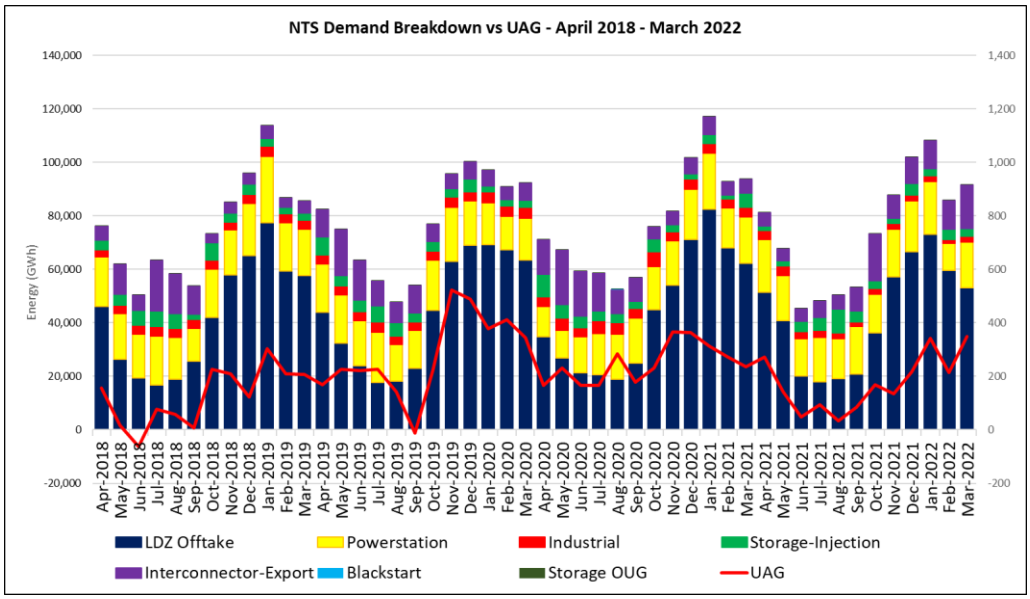

Figure 8: NTS demand breakdown – April 2018 to March 2022

LDZ Offtakes are the largest component of NTS Demand during the winter months, which coincides with the increase in assessed UAG that has been observed in the last three Formula Years. LDZ Offtakes have been individually and collectively assessed against daily UAG to establish if there are any relationships in behaviour. No significant correlation has been identified.

Figure 9 below demonstrates the increases in monthly Interconnector Export volumes that have been observed over the last 6 months.

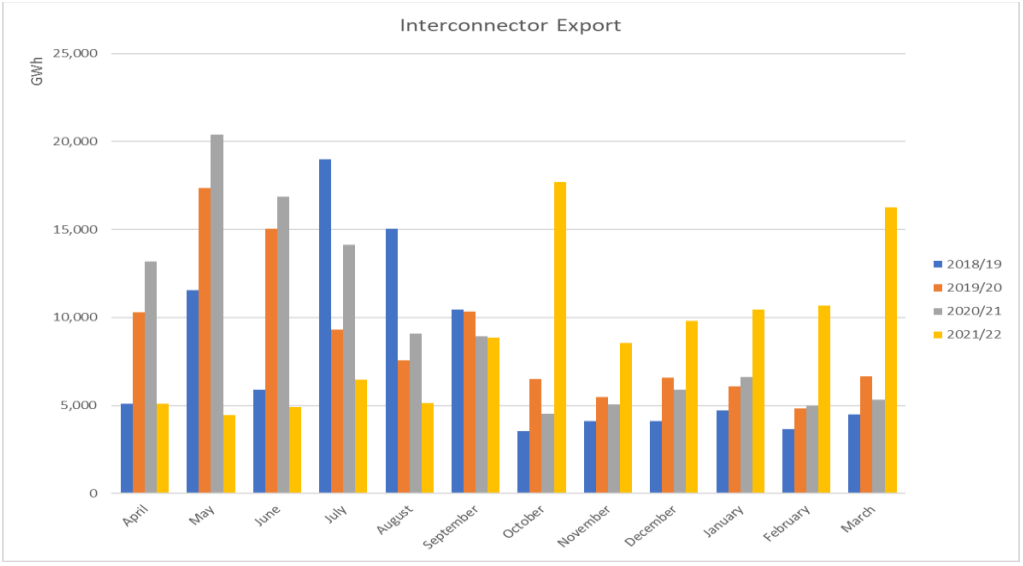

Figure 9: Interconnector Export April 2018 to March 2022

Figure 10 provides an overview of the Supply patterns between April 2018 to March 2022 and demonstrates a seasonal Supply pattern that has been observed in previous UAG Reports. Over the last six months, Terminals and LNG deliveries have increased in line with the seasonal patterns. Interconnector Imports have not been as prominent over the last six months compared to previous years

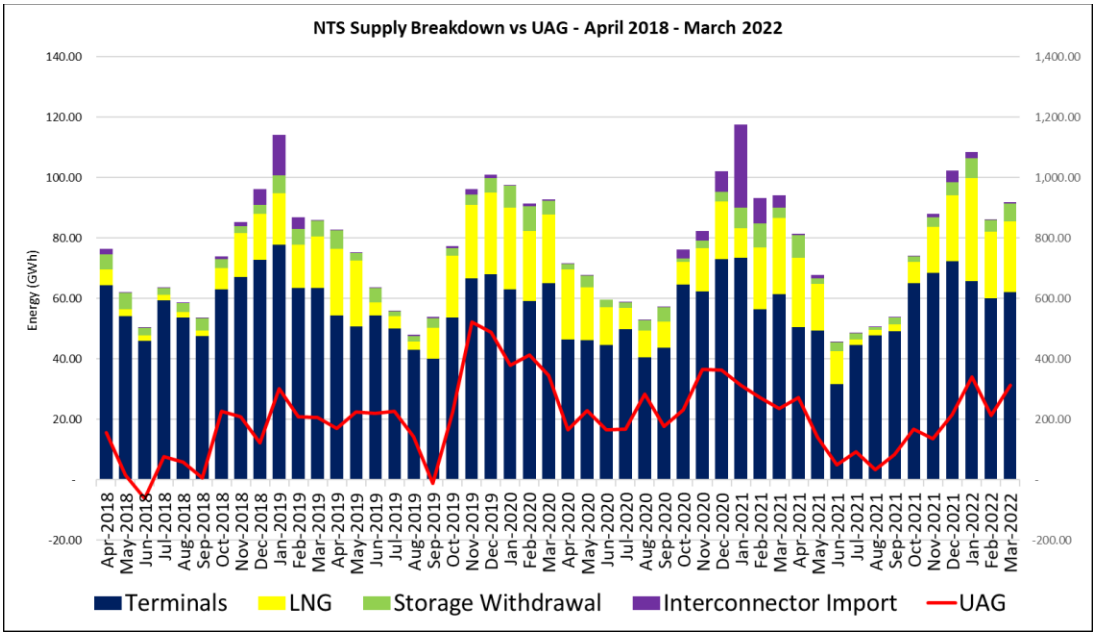

Figure 10: NTS supply breakdown – April 2018 to March 2022

Figure 11 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.

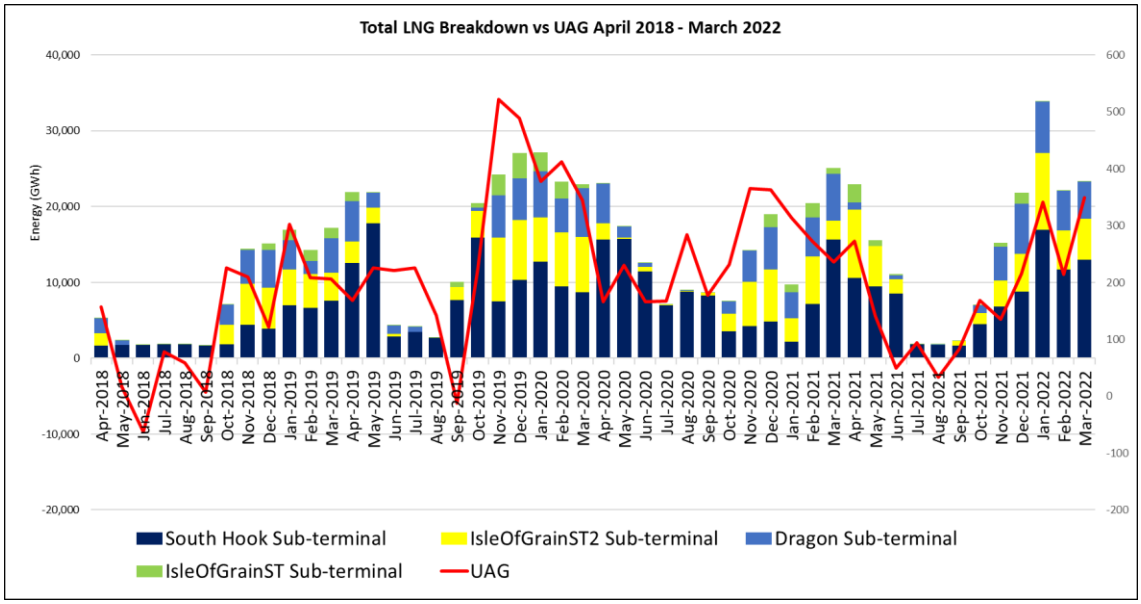

Figure 11: Total LNG breakdown – April 2018 to March 2022

As previously reported, UAG does increase and decrease with LNG flows but so far, there has been no evidence to determine that LNG flows are causing this UAG behaviour, which also broadly align to seasonal throughput trends.

Figure 12 below compares the total monthly LNG Imports since April 2018 and highlights the change in flow patterns that have been observed.

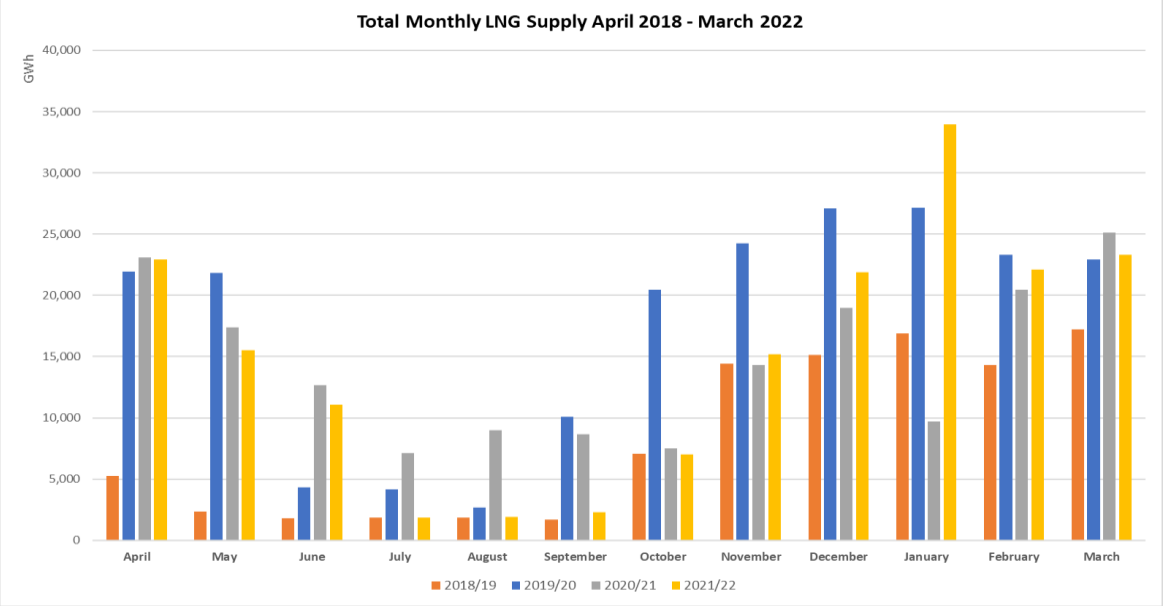

Figure 12: LNG Supply – April 2018 to March 2022

Figure 12 highlights that January 2022 had the greatest levels of LNG delivered onto the NTS, which was 25% higher than the previous largest delivery month in January 2020.

The relationship between UAG and LNG has previously been analysed and no significant correlation has been identified. NGG are looking to explore temperatures being delivered onto the NTS and how that could impact volumetric measurements. Progress of this investigation will be shared in future UAGCVS Reports.

Figure 13 displays the monthly net Interconnector position for Bacton BBL, Bacton IUK and Moffat over the period between April 2016 and March 2022. 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 does not follow a pattern to net Interconnector activity.

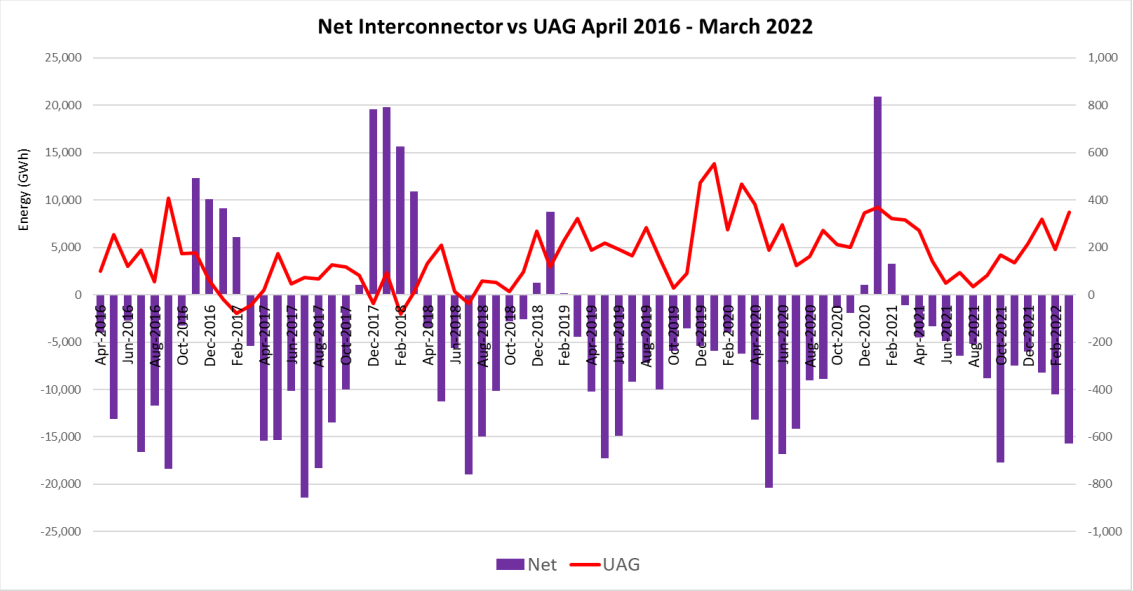

Figure 13: Net Interconnector – April 2016 to March 2022

The Interconnectors on the NTS operate under the "Allocate as Nominate" regime. Therefore, daily Interconnector measurements are determined by the commercial nomination rather than the physical measurement recorded by the fiscal metering on site. This differs from other site types on the NTS and as a result, Interconnectors have an Operational Balancing Account (OBA) which allows them to operate within a 0.3 mcm/d tolerance due to the potential differences the commercial nomination and the physical measurement which is known as the Cumulative Steering Difference. The cumulative impact does not impact UAG costs as over time the values net off but on a daily basis, it can cause spikes in UAG. NGG are considering how daily OBA is currently incorporated into the UAG calculation.

Meter Error is still deemed to be the main cause of UAG. As previously reported, a significant meter error notification was submitted to the Joint Office by Cadent following the identification of a large meter error at Alrewas EM NTS to LDZ Offtake impacting gas days May 2019 to February 2021. Due to the size of the error, two Independent Technical Experts (ITE's) are investigating and documenting their findings. Once the ITE's have completed their investigations and the Meter Error Report has been made publicly available, NGG will submit the corrected measurements to Correla to be issued on a subsequent invoice to correct the invoice values.

Formula Year 2021/22

This section of the report provides data on assessed UAG levels for the April 2021 to March 2022 period. This is the first opportunity for NGG to provide commentary on the full Formula Year.

2021/22	UAG	OUG	CVS	Total
Annual Assessed Levels (GWh)	2,015	1,139	317	3,506
Percentage of NTS Shrinkage	58.5	32.5	9.0	100

Table 2: Actual Assessed Levels for UAG, OUG and CVS – 2021/22

Table 2 provides the annual assessed levels of UAG, OUG and CVS for Formula year 2021/22. The table confirms that UAG was the predominant component of NTS Shrinkage which continues the trend seen in recent years.

Annual Assessed UAG has decreased from the previous year by 31%.

The decrease in UAG has been mainly attributed to a reduction in the magnitude of the positive days and an increase in the number of negative days observed. The total quantity of UAG on days that exceed +20 GWh for 2020/21 is 1,527.4 GWh, which has reduced by 21.4% when compared to the total of 1,200.4 GWh in 2021/22. Additionally, there has been 105 negative UAG days that span between 0 and -19.9 GWh in 2021/22 which is a 50% increase when compared to 70 negative UAG days observed in 2020/21.

NGG have also observed a 34% increase in CVS compared to 2020/21 and a decrease of 6% in annual assessed OUG.

Figure 14 below provides the total monthly assessed UAG for April 2021 to March 2022 compared to the equivalent months in 2020/21. During 2021/22, the total monthly assessed UAG varied from +34.30 GWh to +349.08 GWh with a monthly average of 170.93 GWh.

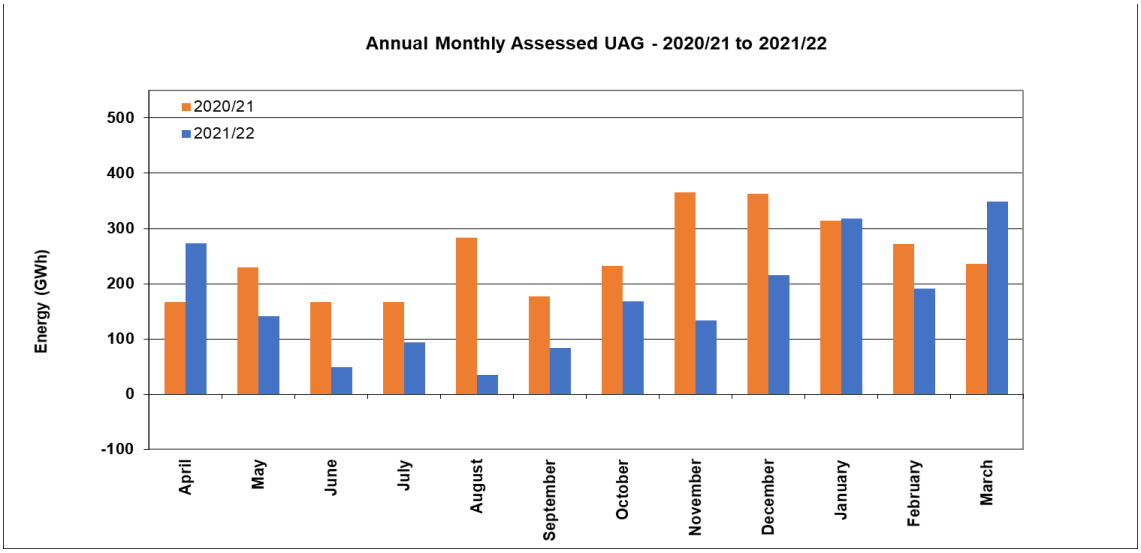

Figure 14: Monthly Assessed UAG 2020/21 to 2021/22

Figure 14 confirms the profile of monthly assessed UAG for both 2021/22 against the same months in 2020/21. These patterns are not as comparable to those observed in previous reports, although seasonal patterns are still being observed with UAG increasing during the winter months and decreasing during the summer months. The seasonal profile observed during 2021/22 has not been of the same magnitude as 2020/21, which is partly due to the increase in negative days which has been discussed earlier in the report.

Figure 15 below provides the daily assessed UAG values between April 2021 and March 2022. Daily variability has continued to be observed with UAG varying from -38.81 GWh to +47.22 GWh and a daily average of 5.62 GWh.

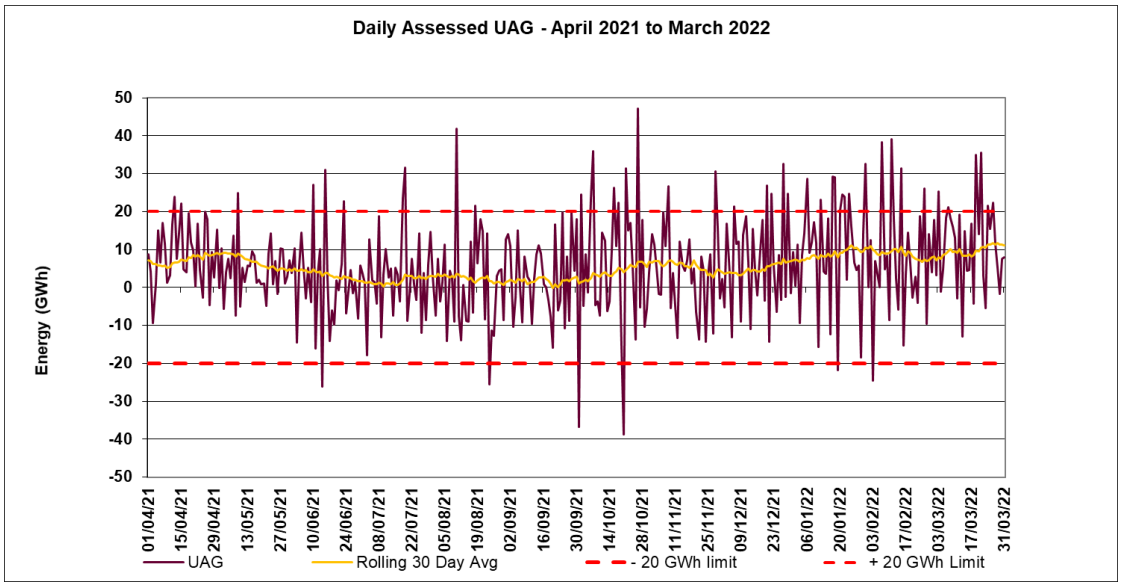

Figure 15: Daily UAG April 2021 to March 2022

The yellow 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 remaining largely flat throughout the period, however, it does increase slightly in October 2021 and again in January 2022.

During 2021/22 13% of the days exceeded ± 20 GWh and 30% of days within the period were negative.

As described previously in this report, NGG 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 NGG to investigate UAG trends, develop analytics and improve their understanding of UAG. UAG trends are a series of consistent patterns of UAG and have so far been investigated using Data Science and Correlation Analysis.

UAG Management Activities

This section of the UAG report describes the various activities and initiatives that NGG 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 NGG as soon as possible after the completion of the validation.

The validation reports provide essential information that allows NGG 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 2021/22 NGG has so far received meter validation reports for 213 NTS entry and exit facilities, these reports are for validations that have taken place between April 2021 and March 2022

The Meter Assurance team has reviewed all of the 213 Meter validation reports received so far. NGG 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 2021/22 review period. The data provided and results recorded will be used to develop the meter witnessing programme for 2022/23.

During meter validations, the meter installation equipment is interfered with by the personnel undertaking the testing. This may include making modifications to the metering system in order to simulate and record values which entails disconnecting physical instruments, wires and software. There is a risk that meter error could be introduced through these activities. NGG is continuing to investigate the potential to identify assessed UAG when meter validations are known to be taking place.

NGG 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 NGG personnel attending metering installations throughout the UK during meter validations to observe and document the testing taking place. Due to COVID-19 restrictions, social distancing, and number of people safe to be on site, NGG has not planned to witness any annual meter validations throughout 2021/22. However, Relationships with asset owners has still been maintained throughout the pandemic via telephone and email.

NGG plans to develop a meter witnessing schedule for 2022/23 and will be engaging with NTS asset owners in due course.

Reconciliation

NGG 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 2021 UAG Report, NGG has adjusted 123.10 GWh in absolute energy terms via the reconciliation process. This comprises of 21 instances of reconciliation at individual NTS entry and exit facilities, each instance comprising of one or more days of reconciliation for a total of 342 gas days. The majority of these reconciliations have been in Formula Year 2021/22; however, reconciliations have also been processed for 2018/19, 2019/20 and 2020/21.

Figure 16 provides the annual reconciliation quantities, in absolute energy terms, for 2013/14 to 2021/22. The orange portion of the bars indicate the reconciliation quantities processed since the publication of the November 2021 UAG report.

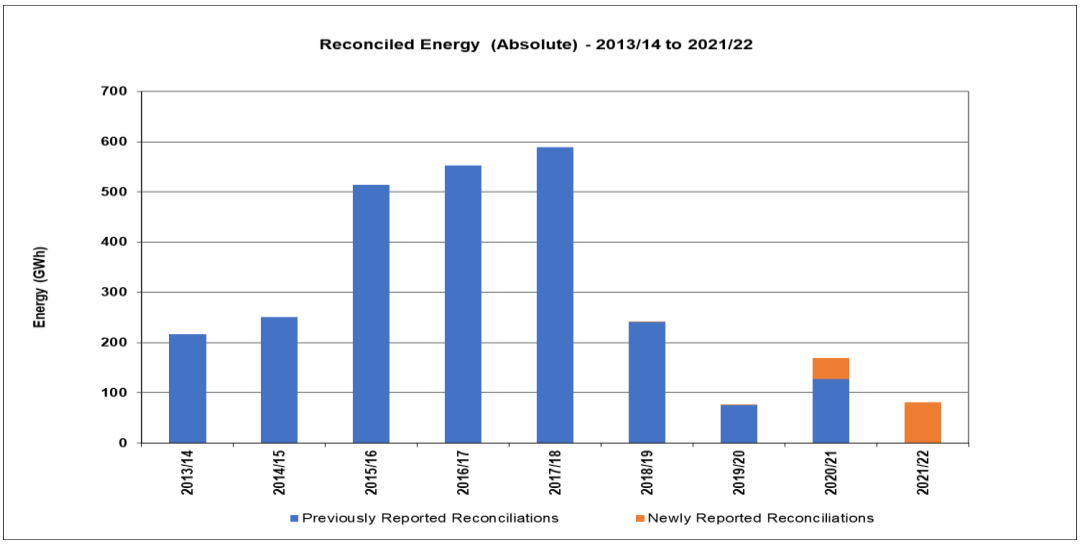

Figure 16: Reconciled energies (absolute) – 2013/14 to 2021/22

Of the 21 instances of reconciliation processed, 5 related to meter error (24% of instances) and 16 related to data error (76% of instances).

NGG 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 is the automated handling of their data which loads directly into the GCS system, reducing the opportunity for manual input errors to occur. NGG hopes that this can be rolled out to NTS Storage sites in the future.

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

UAG Investigation

NGG manage projects to investigate the causes of UAG, particular interest has been the increase of assessed UAG that has been observed since October 2019. The projects also include historical and future UAG patterns or trends.

NGG 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 November 2021 UAGCVS Report projects have been undertaken to review the following:

Considering options for OBA Net Steering Difference and its impact on the UAG calculation. As previously mentioned in the report, the Net Steering Difference is the daily difference between the net nominations and the net physical measurements at the Interconnectors. The current regime allows for the Interconnectors to be billed on a "Allocate as Nominate" basis rather than being based on their physical measurements.

Adjacent TSO's manage the Cumulative Steering Difference which is also through their Operational Balancing Accounts (OBA). Normal operation of the Cumulative Steering Difference would see each TSO's daily values fluctuate between ± 0.3 mcm in order to capture the differences between the commercial nomination and the physical measurement. However, there have been instances where the TSO's have been operating outside of these limits.

NGG have carried out an assessment to understand if any changes could be made to the Linepack calculation and how any changes would impact the daily Linepack Delta which is used as part of the daily UAG calculation.

The current calculation uses fixed temperatures at locations across the 12 zones to derive linepack volumes within the NTS. This is based on a PTZ calculation - Pressure (P), Temperature (T) and Compressibility (Z). The equation can be found below:

$$V_b = V_f \frac{P_{avg}}{P_b} \frac{T_b}{T_{avg}} \frac{Z_b}{Z_{avg}},$$

The investigation utilised average ground temperatures across the UK which were applied to the relevant NTS zones. The fixed temperatures, which are currently in use, could be assessed to determine if any alternatives could improve the linepack calculation.

As a proof of concept for this exercise a sample set of data was taken from the SCADA system. Five different variations of temperatures were adopted to calculate linepack for each zone, which included:

1. The existing SCADA fixed temperature
2. Lowest regional ground temperature
3. Highest regional ground temperature
4. Average regional ground temperature
5. Live flow temperature data

The table below displays the findings from this proof-of-concept investigation.

	Calculated Linepack (SCADA Fixed Temp)	Using Regional **Lowest** Ground Temp (Feb)	Diff MCM	Diff %	Using Regional **Highest** Ground Temp (Aug)	Diff MCM	Diff %	Using Regional **Annual Average** Ground Temp	Diff MCM	Diff %	Using Live FT Data	Diff MCM	Diff %
Zone 0	47.4637829	48.99443517	1.53	3.22	47.3486801	-0.12	-0.24	48.18135743	0.72	1.51	47.2809974	-0.18	-0.39
Zone 1	25.27616913	26.04362173	0.77	3.04	25.15470228	-0.12	-0.48	25.60365527	0.33	1.30	24.96571182	-0.31	-1.23
Zone 2	32.67237216	33.67734086	1.00	3.08	32.52786773	-0.14	-0.44	33.10841459	0.44	1.33	32.37299421	-0.30	-0.92
Zone 3	54.82535709	56.07606392	1.25	2.28	54.16207882	-0.66	-1.21	55.12874607	0.30	0.55	53.6601107	-1.17	-2.13
Zone 4	38.69946054	39.62065222	0.92	2.38	38.26832232	-0.43	-1.11	38.95132295	0.25	0.65	37.92786804	-0.77	-1.99
Zone 5	38.40755704	39.33857633	0.93	2.42	37.87042508	-0.54	-1.40	38.59665245	0.19	0.49	37.15085397	-1.26	-3.27
Zone 6	13.6712775	13.9188353	0.25	1.81	13.45490624	-0.22	-1.58	13.68462531	0.01	0.10	13.31889372	-0.35	-2.58
Zone 7	40.5388955	41.55619251	1.02	2.51	40.15088984	-0.39	-0.96	40.8421736	0.30	0.75	38.93821649	-1.60	-3.95
Zone 8	6.921272015	6.983012079	0.06	0.89	6.722399752	-0.20	-2.87	6.851312767	-0.07	-1.01	6.749960912	-0.17	-2.48
Zone 9	11.41605369	11.6797846	0.26	2.31	11.28481079	-0.13	-1.15	11.47910243	0.06	0.55	10.84471269	-0.57	-5.00
Zone 10	7.89073962	7.990584666	0.10	1.27	7.720367658	-0.17	-2.16	7.853290362	-0.04	-0.47	7.446649068	-0.44	-5.63
Zone 11	25.57303389	25.6564625	0.08	0.33	24.80130629	-0.77	-3.02	25.22474535	-0.35	-1.36	25.06513444	-0.51	-1.99
TOTALS	343.36	351.54	8.18		339.47	-3.89		345.51	2.15		335.7221034	-7.63	

Table 3: Linepack calculation differences

Differences in linepack were identified when comparing the fixed temperatures in the linepack calculation to ground temperatures. However, this does not necessarily mean that a change in daily linepack would lead to UAG. The largest difference was witnessed when the lowest regional temperatures were used, with a difference of 8.18 mcm (2.28%). The smallest differences were observed when using an annual regional average ground temperature which produced a difference of 2.15 mcm (0.63%).

NGG have discounted the option of using live flow temperature as the instruments on the NTS are susceptible to ambient weather changes and flow conditions, this information is found on the right-hand side of the table.

In the next phase of the investigation, NGG is going to explore the concept of using a dynamic solution that utilises a daily ground temperature derived from ground temperature averages taken from previous years' data, including any impact this may have on the UAG calculation.

NGG will need to carefully consider any change to the calculation and any of the wider commercial and physical impacts and no changes would be made to linepack without consultation.

Figure 17 below confirms the daily energy difference across the NTS between April 2021 to March 2022. It highlights the differences between a measured and calculated energy from the volumetric measurement. The volume has been converted to energy using an assumption that the CV across the NTS is 39.6 MJ/m3.

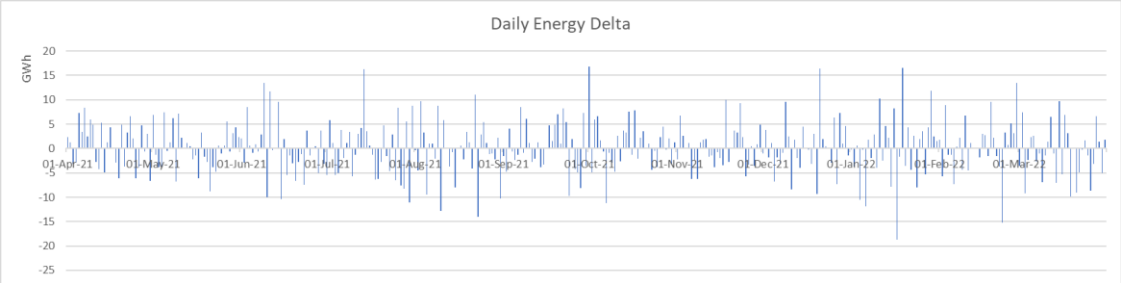

Figure 17: Daily Energy Delta April 2021 – March 2022

The daily average difference between the recorded energy and the calculated energy is 0.08 GWh/d with a minimum daily difference of -18.75 GWh and a maximum of +16.84 GWh. NGG are developing a process to monitor the differences between the measured and calculated energy that exceed this typical range.

As mentioned in the November 2021 report, a new data model has been developed and a suite of new dashboards have been produced to enhance NGG's ability to visualise and validate daily measurements.

Through the use dashboards and visualisations of raw metering and flow data in the Tableau system, NGG have been able to conduct more advanced measurement checking for NTS entry and exit points within the measurement closeout windows.

NGG is undertaking a comprehensive review of all data visualisation tools with the aim of standardising process and investigation steps to better manage the outcomes and findings. NGG hope this will improve the accuracy of the end of day measurements across the network and will lead to further reductions in reconciliations caused by data and system error. The data visualisation and investigative tools will receive annual reviews to ensure they are fit for purpose and continue deliver value.

A review of a potential analytical tool and its mathematical models has been completed by a data scientist. This has allowed a deeper understanding of its capability and will help to scope the next phase of its development to enable causation analysis of UAG at site level. Progress on the causality detection tool is dependent upon having a data science resource and at present, NGG are unable to confirm when this will be progressed.

Table 4 provides an overview of the UAG projects and initiatives NGG have planned over this Formula Year (2021/22).

Project / Initiative	Target Completion Date	UAG / CVS	OUTCOME
Enhancements to UAG Causality detection models	Wider 2022/23 reporting period	UAG	N/A for this report due to Data Science resource availability
Linepack calculation improvements	Wider 2022/23 reporting period	UAG	N/A for this report due to Data Science resource availability. Partly linked to other Linepack initiative where progress has been made
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	Work is ongoing. A review of the existing data visualisation tools has taken place to standardise investigation and results across the team
Linepack Analysis using ground temperature	November 2022 Reporting Period	UAG	Progress has been made on a sample. Will be scaled up and findings brought to a future report. Considering further data science analysis
Consider impact of OBA on UAG calculation	November 2022 Reporting Period	UAG	Work is ongoing, outcome N/A for this report
Calculate UAG zonally across the NTS	Wider 2022/23 reporting period	UAG	N/A for this report
Review of ± 20 GWh baseline tolerances	Wider 2022/23 reporting period	UAG	N/A for this report due to Data Science resource availability
Investigate the impact of a lower Wobbe Index at NTS input terminals and how it could influence CVS	Wider 2022/23 reporting period	CVS	N/A for this report

Table 4: Project initiatives for Formula Year 2022/23

Tableau Analysis

NGG utilises Tableau software to visualise and analyse its data. Current Tableau dashboards are enabling to us to identify and minimise data errors within the closeout period. These are being enhanced as new and improved data models become available.

NGG has developed a dashboard to support the validation of pre close-out measurements and Shipper allocations allowing the team to identify error by comparing settled data to instantaneous telemetered data. This has been made possible due to an improved data model which NGG continues to develop to allow further visualisation tools to be built.

As further developments are made, NGG will provide updates in future reports.

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, NGG deduct 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, NGG 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.

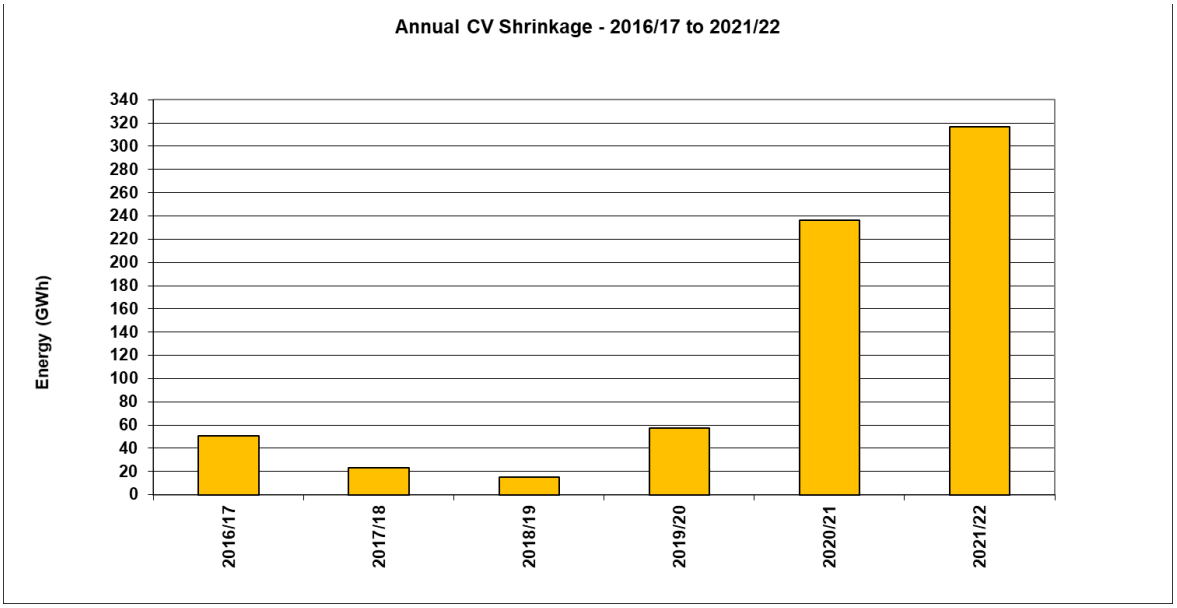

Figure 18 - Annual CVS 2016/17 to 2021/22

Figure 18 provides total annual CVS for Formula Years 2016/17 to 2021/22 and indicates that CVS has been increasing annually since 2018/19. Total CVS in 2021/22 has increased by 34% since the previous Formula Year with a significant increase of 2,002% when compared to 2018/19.

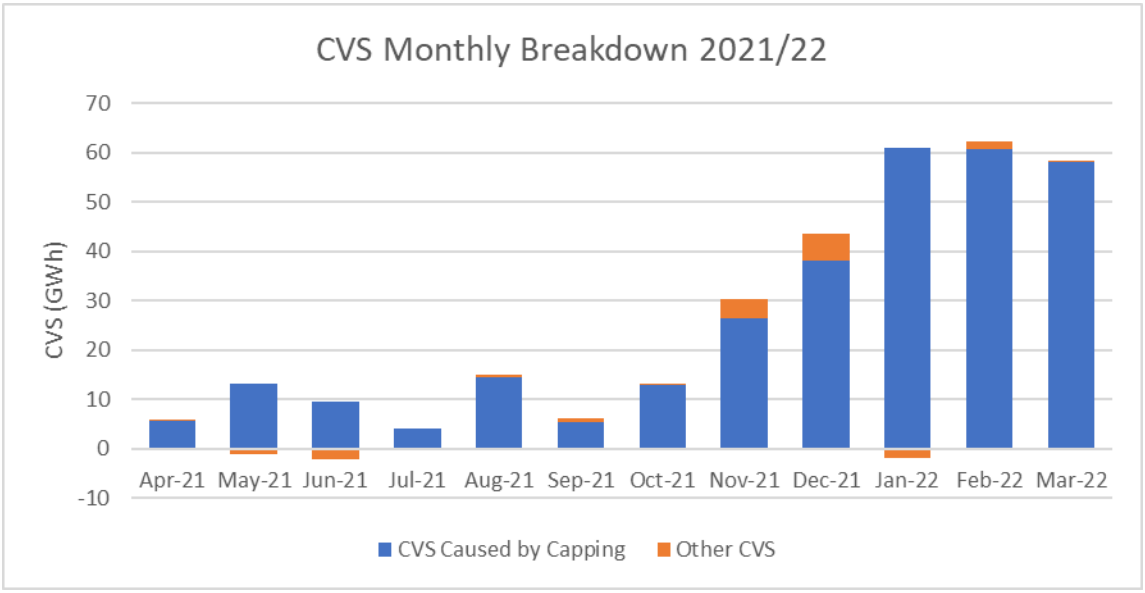

Figure 19 - CVS Monthly Breakdown 2021/22

Figure 19 provides a monthly breakdown of CVS for Formula Year 2021/22. The blue section of the bars represent CVS caused by capping within the LDZ's and the orange sections represent CVS not caused by CV capping. CVS 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 257.44 GWh and has predominately been observed in Northern (NO) and North East (NE) LDZs.

NE has seen an increase of 1,169% and NO has increased by 22% when compared to the previous 6-month period. CV capping has been observed in the following LDZ's over the last six months EM, NE, NO, NW, SC, SE, SW and WM.

	CVS Caused by Capping (GWh)											
Month	EA	EM	NE	NO	NT	NW	SC	SE	SO	SW	WM	WN
Apr-21	0.81	0.00	3.15	1.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May-21	0.00	5.01	8.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jun-21	0.34	2.44	3.29	1.71	0.00	1.12	0.14	0.00	0.00	0.00	0.00	0.00
Jul-21	1.25	0.00	0.69	0.96	0.26	0.00	0.00	0.00	0.00	-0.03	0.89	0.00
Aug-21	0.00	0.00	0.14	14.11	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.00
Sep-21	0.00	0.72	0.00	4.59	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00
Oct-21	0.00	0.00	1.80	8.92	0.00	0.52	0.00	0.23	0.00	0.00	1.36	0.00
Nov-21	0.00	0.00	20.99	2.81	0.00	0.00	1.81	0.00	0.00	0.82	0.00	0.00
Dec-21	0.00	0.00	35.50	2.18	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.00
Jan-22	0.00	0.00	41.09	7.10	0.00	12.87	0.00	0.00	0.00	0.00	0.00	0.00
Feb-22	0.00	0.00	58.86	1.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar-22	0.00	0.88	37.71	5.05	0.00	12.44	2.06	0.00	0.00	0.00	0.00	0.00

Table 5: CVS Caused by capping (GWh)

CV capping witnessed in NO and NE LDZ's over that last 6 months has been due to greater supplies of gas entering the region from the Teesside (NE) and Easington (NE) terminals. These terminals typically supply higher CV gas onto the NTS compared to gas flows entering those regions from St Fergus terminals with typically lower CV's. Due to the location of these input terminals and the network configuration, blending of the higher and lower quality CV gases cannot be achieved before it reaches the Offtake facilities within the LDZ's. Therefore, there is often a disparity in CV's entering those LDZ's, causing CV capping to occur.

NGG is undertaking some maintenance activities at St Fergus ASEP and during this time the facility to blend gases coming from the St Fergus Sub Terminals will be unavailable. Therefore, a risk of increased levels of CVS due to CV capping has been identified and a contingency plan has been implemented into the Non-Routine Operation (NRO). The contingency plan outlines flow management techniques which were utilised during a previous period of maintenance, which resulted in the minimisation of CV differences being delivered through the ASEP and therefore reducing the risk of CV capping. Once the maintenance activities are complete, further information will be shared in future UAGCVS Reports to confirm the effectiveness of the contingency planning for reducing the risk of CV capping.

Conclusion

The total assessed UAG quantity for the October 2021 to March 2022 period is greater than the previous six-month period. Monthly assessed UAG is also greater than the long-term average (April 2013 to March 2022) for 4 of the last 6 months, which is in line with increased throughput through the Winter period compared to the annual average.

NGG has continued to improve its understanding of the causes of UAG through the use of data visualisation tools and investigative projects.

CVS has increased in Formula Year 2021/22 when compared to the previous year. CV Capping has continued to contribute towards the increase which has predominately been witnessed in NO and NE LDZs.

Continued support from meter owners has enabled NGG 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 NGG's ability to detect meter error and to inform the preparation of future meter witnessing programmes.

Appendix I - National Grid Gas Plc (NTS) Gas Transporter Licence Special Condition Part J 5.6

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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