nationalgrid

Unaccounted for Gas Report

National Grid

Gas Transmission

October 2018

Target audience

Ofgem and other interested industry parties

About this document

This document sets out the work undertaken by National Grid Gas, in its role as System Operator, to investigate potential causes of Unaccounted for Gas (UAG).

It is published to meet National Grid Gas Plc (NTS) Gas Transporter Licence Special Condition 8E: Requirement to undertake UAG Projects to investigate the causes of Unaccounted for Gas (UAG).

Executive Summary

This report provides a review of National Grid's Unaccounted for Gas (UAG) management since April 2013, the start of the RIIO-T1 price control, with particular emphasis on 1st March to 31st August 2018 inclusive, the period since the publication of the April 2018 UAG report.

The total assessed UAG quantity for the March 2018 to August 2018 period has reduced from the previous six month period. In addition, total monthly assessed UAG values have been predominantly less than the long-term average (April 2013 to August 2018) monthly assessed UAG.

It is expected that for Formula Year 2018/19, annual assessed UAG will be less than for Formula Year 2017/18 which supports the decline in annual quantities observed since 2009/10. Despite the decline in annual assessed UAG, National Grid is expecting to process a greater quantity of meter and data error reconciliation in absolute energy terms for 2018/19 than what was reconciled for 2017/18.

Improvement of enhancing National Grid's analytical ability through the deployment of improved data visualisation tools continues to support its ongoing work into the investigation of the causes of UAG. This is assisting National Grid to identify and correct data errors during the pre-closeout period.

Continued support from meter owners has enabled National Grid 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 and to inform the preparation of future meter witnessing programmes.

Contents

1. Introduction

This report provides a review of National Grid's Unaccounted for Gas (UAG) management. The report provides information on assessed Unaccounted for Gas quantities since April 2013, the start of the RIIO-T1 price control, with specific emphasis on 1st March to 31st August 2018 inclusive, which is the period since the publication of the April 2018 UAG report. It also describes the various activities and initiatives that National Grid has been undertaking or is planning to undertake to investigate the causes of UAG.

UAG is one of the three components of NTS Shrinkage together with Own Use Gas (OUG) and CV Shrinkage (CVS). Further information on the components of NTS Shrinkage can be found on the National Grid website via the following link: https://www.nationalgridgas.com/balancing/unaccounted-gas-uag

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

- all previous UAG reports
- daily data on the components of NTS Shrinkage including UAG which are available on the National Grid website via the above link.

This report and the UAG related data published on the National Grid website discharge National Grid Gas's responsibilities under the Gas Transporter Licence Special Condition 8E: Requirement to undertake UAG Projects to investigate the causes of Unaccounted for Gas (UAG). Special Condition 8E is reproduced in Appendix I of the report. The relevant data used to produce the tables and graphs included in the report is provided or referenced in Appendix II.

If you have any feedback or questions on this document, please contact the National Grid Meter Assurance team via the meterassurance@nationalgrid.com email address. Meter Assurance, who are part of the Energy Balancing team within National Grid's UK Gas System Operator directorate, are responsible for investigating the causes of and reporting upon UAG.

2. National Transmission System Unaccounted for Gas Trends

This section of the Unaccounted for Gas Report provides information on assessed Unaccounted for Gas quantities since April 2013 with emphasis on the period March to August 2018. It also provides a review of the assessed quantities of UAG observed for Formula Year 2017/18.

2.1 Formula Years 2013/14 to 2018/19

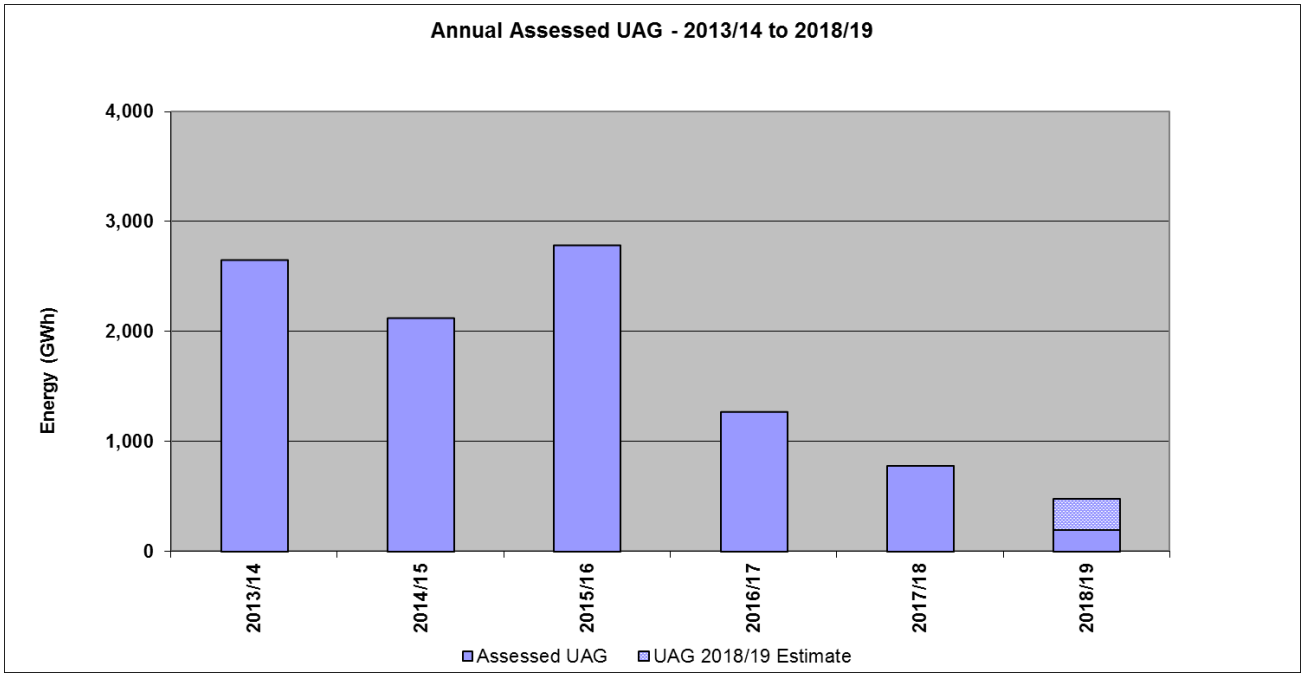

Figure 1: Annual assessed UAG – 2013/14 to 2018/19

Figure 1 provides the annual assessed quantities of UAG for Formula Years 2013/14 to 2018/19. A Formula Year refers to the period from 1st April to 31st March of the following year. Figure 1 also provides an estimate of the additional quantity of UAG that is expected during the remainder of the current Formula Year.

From the above figure, the total assessed UAG quantity for 2018/19 is expected to be lower for the previous year and significantly less than the periods between April 2013 and March 2017. It appears that the year on year reduction in the annual assessed UAG quantities observed since 2009/10, except for 2015/16, will continue.

Table 1 provides the actual assessed and estimated levels for UAG, OUG and CVS for 2018/19. The table indicates that OUG is expected to be the predominant element of NTS Shrinkage for 2018/19. UAG is expected to account for approximately 25% of the total estimated 2018/19 NTS Shrinkage. UAG had been the principal element of NTS Shrinkage each year between 2009/10 and 2016/17.

2018/19	UAG	OUG	CVS	Total
Actual Assessed Levels - April to August (GWh)	202	410	59	671
Estimated Levels – September to March (GWh)	280	918	81	1,279
Estimated Annual Levels (GWh)	481	1,328	140	1,950
Percentage of Total Estimated Annual Level	24.7	68.1	7.2	100.0

Table 1: Actual assessed and estimated levels for UAG, OUG and CVS for 2018/19

Table 2 provides the annual and daily average assessed UAG quantities for Formula Years 2013/14 to 2018/19. 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
Assessed Annual Level (GWh)	2,648	2,121	2,782	1,272	783	202
Assessed Daily Average (GWh/d)	7.25	5.81	7.60	3.48	2.14	1.32
Percentage of NTS Throughput	0.29	0.23	0.29	0.13	0.08	0.07

Table 2: Statistical performance of UAG - 2013/14 to 2018/19

The values provided in the above table for 2018/19 cover a five month period from 1st April to 31st August and indicate that the daily average assessed UAG quantity for the year is currently lower than that reported for the previous year. UAG as a percentage of annual NTS Throughput for 2018/19 is currently expected to be very similar to 2017/18.

Figure 2 provides the total monthly assessed UAG from April 2013 to August 2018. It also provides the average monthly assessed UAG for this period (150.89 GWh). For the last 23 months, total monthly assessed UAG has been less than the long-term average monthly assessed UAG.

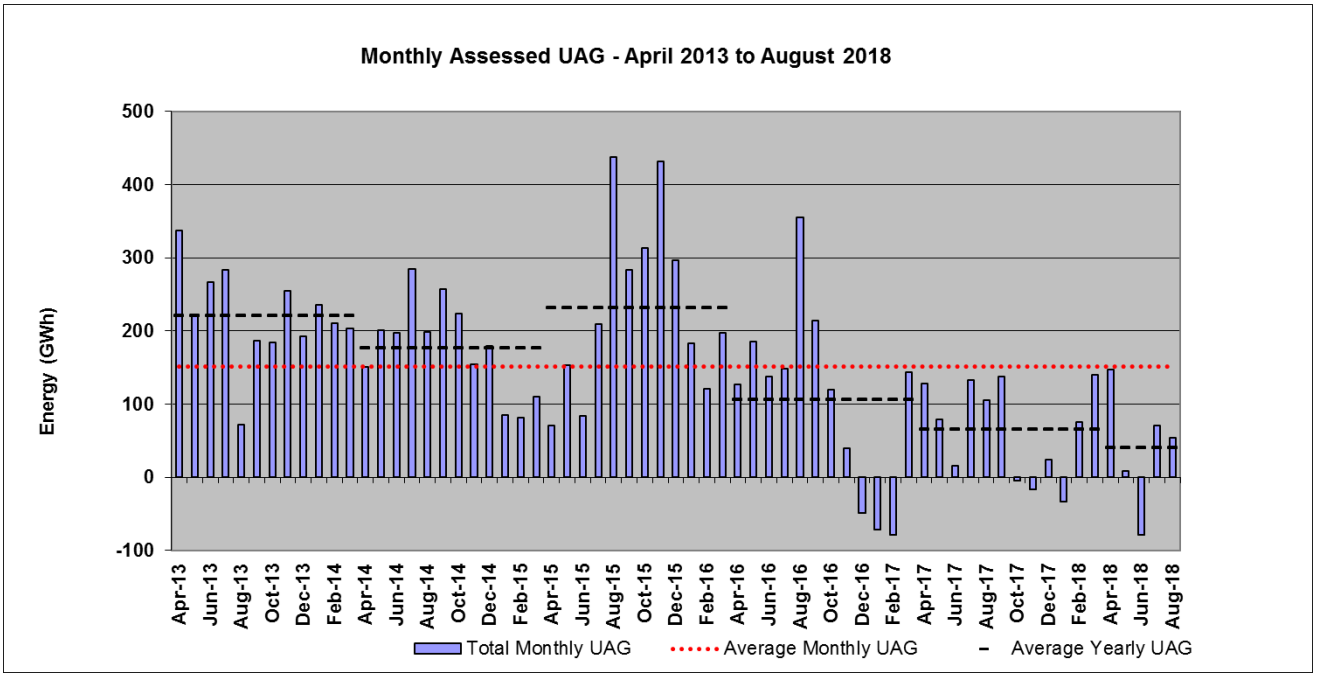

Figure 2: Monthly assessed UAG - April 2013 to August 2018

Very low levels of total monthly assessed UAG have been observed for the majority of the March to August 2018 period. During this time, the total monthly assessed UAG varied from -78.32 GWh to +147.69 GWh with a monthly average of 56.86 GWh. The total monthly assessed UAG value was negative in June 2018 and the long-term average monthly assessed UAG has reduced since the last publication of the UAG report.

There appears to be a change in bias since the middle period of 2016, as represented in Figure 2 from the black dotted lines. National Grid is investigating potential causes of this change in bias.

The total monthly assessed UAG provided in Figure 3 compares March to August 2018 with the equivalent months in 2017. A similar pattern of total monthly assessed UAG over the two Formula Years is apparent, with May and June being the lowest months during each period. UAG is lower in five of the last six months in comparison to 2017.

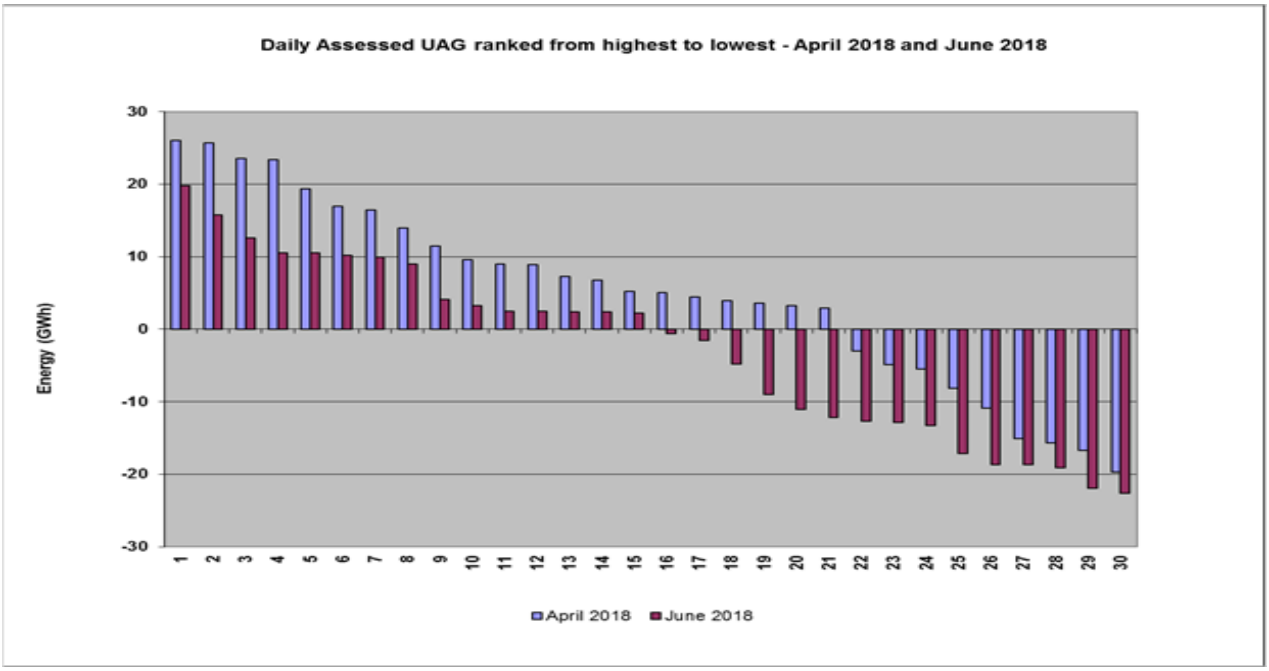

Figure 3: Daily assessed UAG ranked from highest to lowest - April 2018 and June 2018

There were 15 instances of negative UAG days in June 2018. Figure 3 provides a comparison of daily assessed UAG for April 2018, which was predominantly positive against June 2018 which displays low and more negative UAG days. This UAG pattern in June comprising of very low positive UAG and larger more frequent negative days over that month resulted in the low total monthly assessed UAG seen in figure 4.

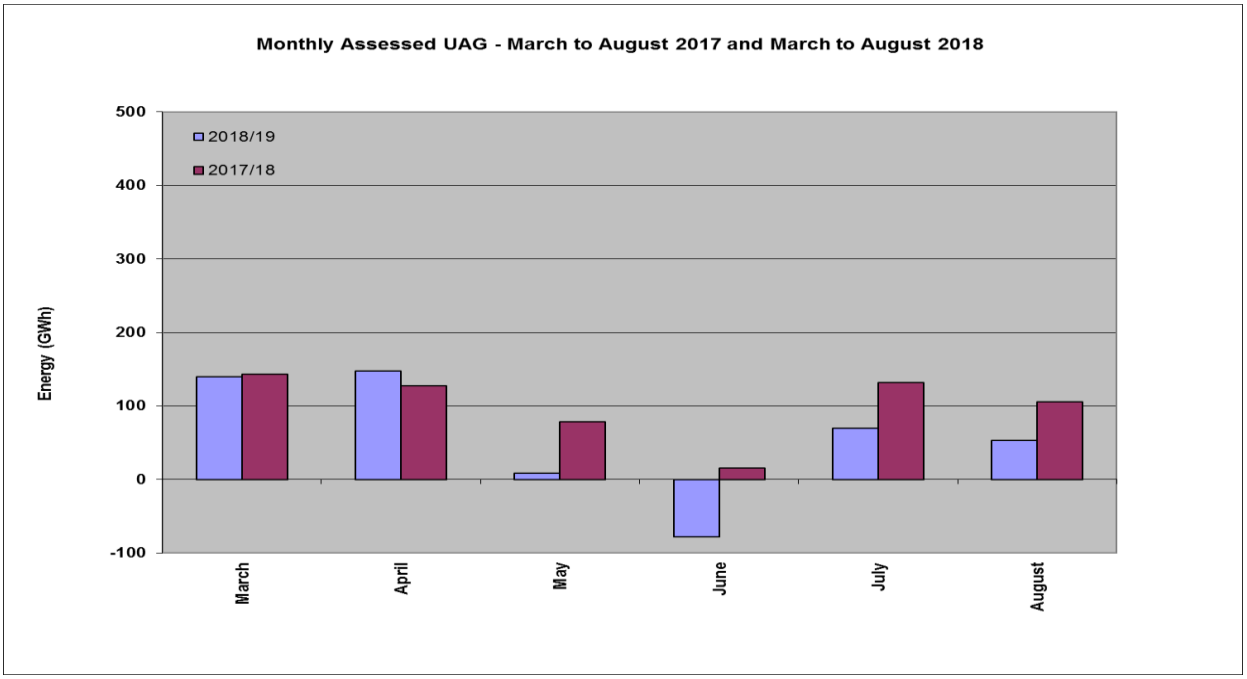

Figure 4: Monthly Assessed UAG - March to August 2017 and March to August 2018

As suggested in the previous UAG report, one line of enquiry was to investigate a possible correlation between the low UAG levels to the changes in flow patterns of the interconnectors connected to the gas National Transmission System (NTS), particularly regarding the period between September 2017 to February 2018. The results of these tests did not identify any obvious patterns or correlations when comparing UAG to the imported and exported values at these particular sites. Analysis was also carried out for other entities including power station, large Industrial, storage, LDZ offtake and terminal facilities. Although there was no obvious correlation to UAG patterns, some of these entities displayed a stable energy flow across the period so can therefore be omitted from further investigations of this type.

A plan to assess the relationships between levels of UAG with the changes of flow patterns at individual sites will commence over the coming months.

Further development of tools such as Tableau, should support future analysis of UAG behaviour (refer to section 3.6 of the report).

Figure 5 below provides the daily assessed UAG values for 1st March 2018 to 31st August 2018, indicating a continued large day to day variability in the daily assessed UAG values. During this period, daily UAG varied between -25.55 GWh to +37.82 GWh which has a noticeably tighter span than the previous six months, which ranged between -38.8 GWh to +54.8 GWh.

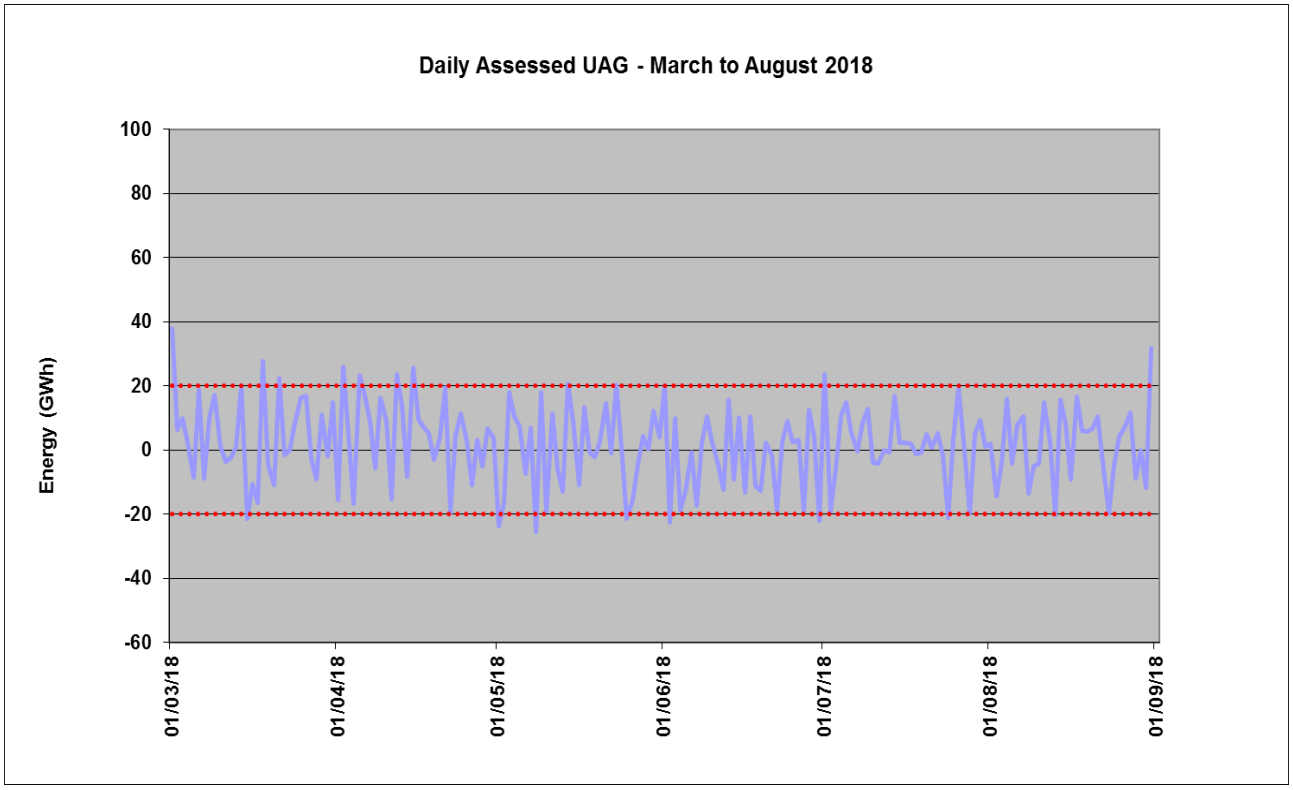

Figure 5: Daily assessed UAG – March to August 2018

There were 77 days (41.8% of occasions) subject to negative UAG during this period. This is a slight decrease from the 85 days (47.0% of occasions) witnessed during the previous six months. A pattern has been detected over the past two years that negative UAG has been prevalent in June and between the months of September and February. National Grid will continue to monitor this behaviour.

National Grid reviews and investigates the assessed UAG values daily, paying attention to any values that exceed ±20 GWh. These baseline UAG quantities are provided as red dotted lines in Figure 5. During the period of March to August 2018 there were 19 days when daily assessed UAG exceeded ±20 GWh (10.3% of occasions), which is a slight increase compared to the 17 days (9.2% of occasions) observed during the previous six month period. Sources of UAG have been identified on a number of days over this period. The magnitude of UAG in absolute energy terms over these incidences was considerably less than for the previous period.

There have been two instances of very high UAG recorded during this period: 1st March (37.82 GWh) and 31st August (31.71 GWh), investigations have not yet identified meter or data error.

National Grid has improved its UAG investigation initiatives which could allow for clearer visualisation when comparing site level energy values across its different systems. Improved data availability and accuracy would provide greater analysis techniques using a new suite of Tableau dashboards. The ongoing development of these dashboards could help to provide a greater insight into the causes of UAG and reduce the data errors that can occur through system and validation processes. Further information on the development of these visualisations is provided in section 3.6 of this report.

2.2 Formula Year 2017/18

National Grid is continuing to develop its tools for analysing and monitoring high levels of UAG. The 35 high UAG days that had occurred over the Formula Year 2017/18 have been all been investigated. Of the last Formula Year, 17.2% of UAG has been identified and reconciled accounting to 162 GWh of identified UAG in absolute energy terms.

This section of the report provides data on assessed UAG levels for the April 2017 to March 2018 period. It expands on the reporting on the first 11 months of this Formula Year included in the October 2017 and April 2018 UAG reports. This is the first opportunity to report on assessed UAG for the entirety of 2017/18 and allows observations to be presented for the whole year.

2017/18	UAG	OUG	CVS	Total
Actual Annual Levels (GWh)	783	2,427	23	3,233
Percentage of Total NTS Shrinkage	24.2	75.1	0.7	100.0

Table 3: Actual assessed levels for UAG, OUG and CVS for 2017/18

Table 3 provides the actual assessed levels for UAG, OUG and CVS for the 2017/18 Formula Year. The table indicates that again OUG was the predominant element of NTS Shrinkage during 2017/18. The decrease in the levels of UAG observed during that year combined with an increase in the levels of OUG observed because of increased compressor usage was the contributing factor. UAG accounted for just under a quarter of the total 2017/18 NTS Shrinkage.

Assessed UAG during 2017/18 was significantly lower than for the previous Formula Year accounting for only 61.5% of the quantity observed during 2016/17.

Figure 6 provides the total monthly assessed UAG for April 2017 to March 2018 compared to the equivalent months of 2016/17. During 2017/18, the total monthly assessed UAG varied from -32.8 GWh (January 2018) to +139.4 GWh (March 2018) with a monthly average of 65.2 GWh.

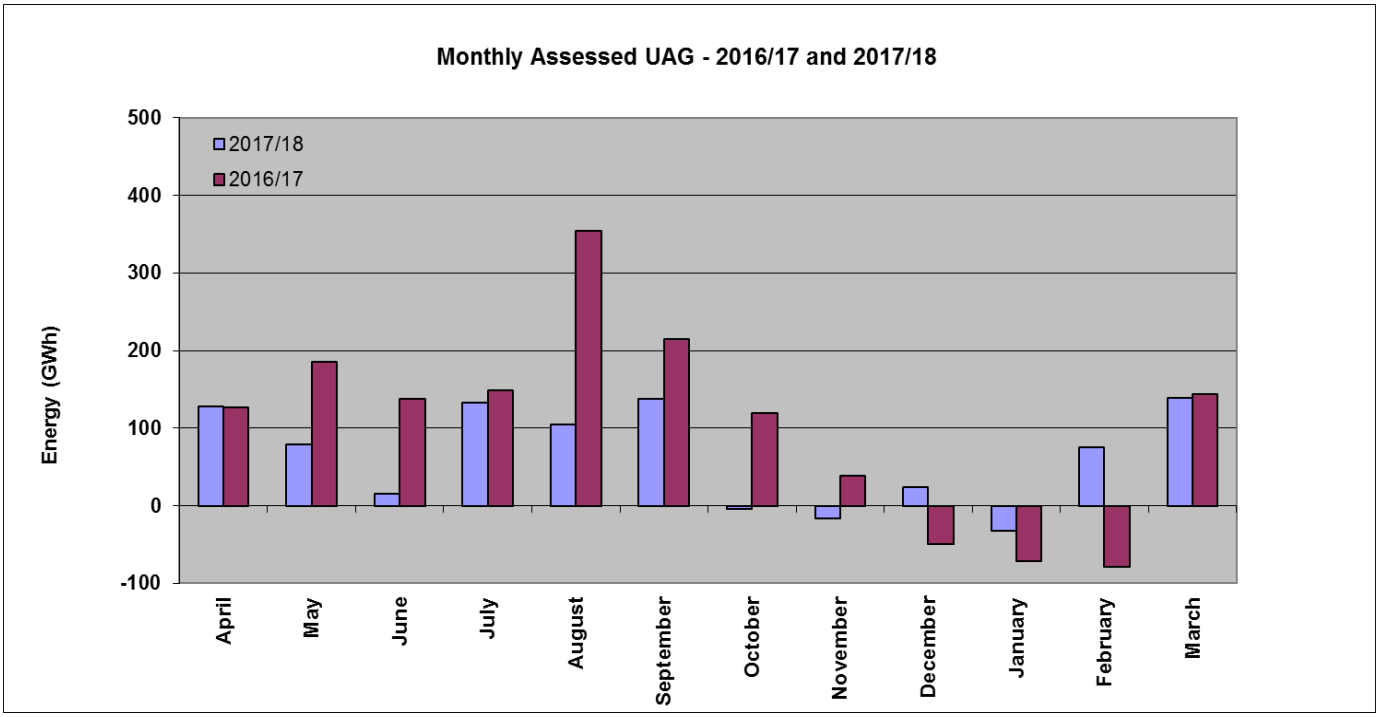

Figure 6: Monthly assessed UAG – 2017/18 and 2016/17

As indicated in Figure 6, the total monthly assessed UAG for 2017/18 was nearer to zero for 11 out of the 12 months. UAG between April and September has been positive with a monthly average of around 100 GWh. Levels of low and negative UAG between October to February appear to follow a similar pattern to that observed in 2016/17. The quantities of negative UAG observed during this period had not been seen in over 10 years but now this behaviour seems to be trending. National Grid is continuing to explore the potential causes of this negative UAG with investigations focussing on identifying potential meter or data error at one or a combination of sites.

Figure 7 provides the daily assessed UAG values for 1st April 2017 to 31st March 2018. Large day to day variability in the daily assessed UAG values has continued with daily UAG varying from -34.5 GWh to +59.6 GWh with a daily average of 2.14 GWh. Negative UAG was observed on 155 days (42.5% of occasions) during 2017/18. The dark red line in the centre illustrates a 30 day rolling average.

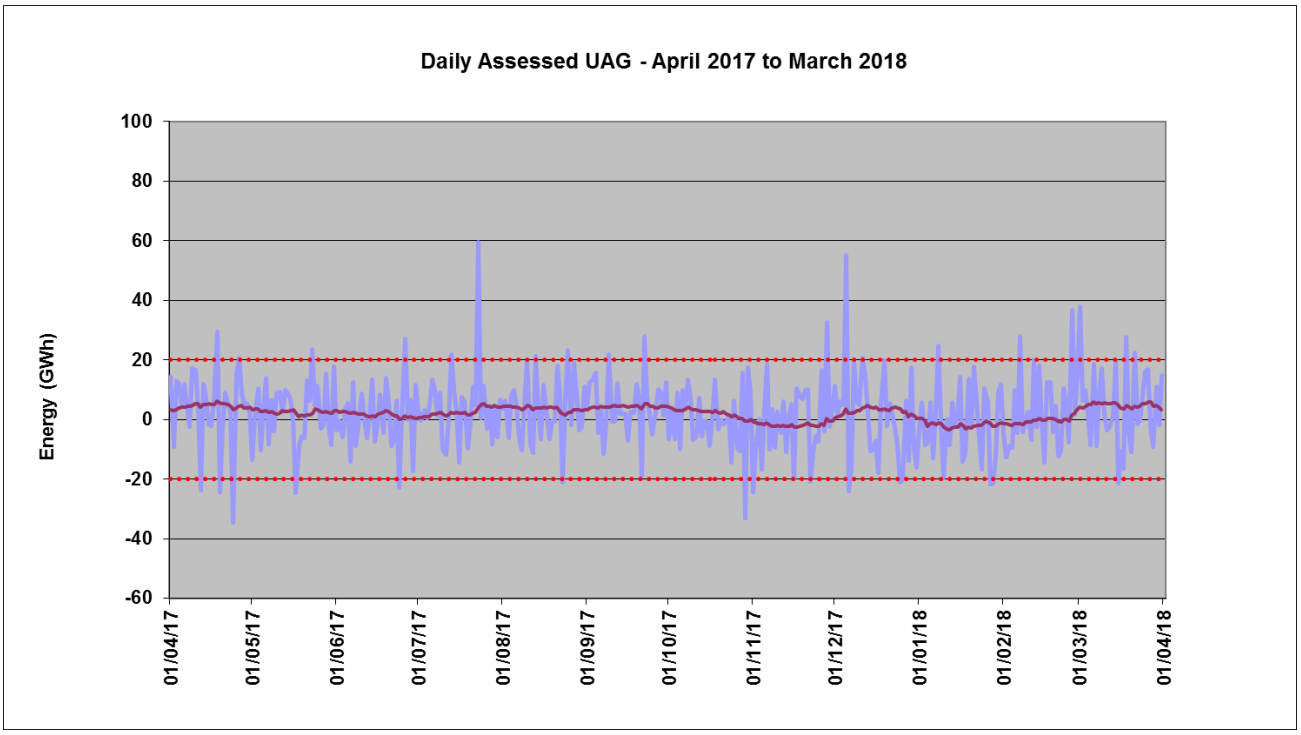

Figure 7: Daily assessed UAG – April 2017 to March 2018

Baseline UAG quantities are provided as red dotted lines in the above figure. During 2017/18 there were 35 days when daily assessed UAG exceeded ±20 GWh (9.6% of occasions).

There were 10 instances of very high positive or negative UAG during the 2017/18 Formula Year. One of the instances of very high negative UAG in April was identified as a data error associated with Langage Power Station, the instance in July was associated to an allocation issue for the IUK

Interconnector and in November and December, data errors were identified associated to the Stallingborough power stations. Reconciliations of these errors have all been progressed. The remaining high UAG dates have not yet been identified as meter or data errors, however work continues to investigate the causes of these UAG levels. Further information on reconciliation is provided in section 3.3 of this report.

Continual review and improvement of current systems, validation checks, data visualisation and analysis tools, including the mathematical analysis Shiny application will assist with future identification of error.

The UAG, OUG and CVS data provided in this section of the report was the data National Grid included in its Regulatory Reporting Pack (RRP) submission to Ofgem for 2017/18.

3. UAG Management Activities

This section of the Unaccounted for Gas Report describes the various activities and initiatives that National Grid has been undertaking or is planning to undertake to investigate the causes of UAG.

3.1 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 functioning correctly. The results of these tests are documented within a meter validation report.

The reports provide vital information that allows National Grid to assess the asset health and accuracy of all metering connected to its network, enabling a better understanding of the impacts that meter error will have on UAG.

With the continued support of meter owners, National Grid received meter validation reports for 95.7% of all the NTS entry and exit facilities for Formula Year 2017/18. These reports related to validations that had taken place between April 2017 and March 2018. Out of the 231 meter validation reports that were requested, 10 reports were not provided. It became apparent that two of the meters had either been out of service for 12 months or fully decommissioned, four sites could not be validated due to other maintenance issues and the remaining four sites were either late or incomplete.

The 221 reports received were reviewed by the Meter Assurance team and where necessary, queries were raised with meter owners. Only four meter installations (2% of all NTS entry and exit facilities)

were assessed to have failed their meter validations. Actions were put into place with the meter owners to identify the root cause of each error. After further analysis, it was confirmed that these errors were small and therefore would not have had a material impact on assessed UAG levels.

The outcome of the meter validation reports reviewed during 2017/18 were used to inform the preparation of the meter witnessing campaign for 2018/19.

For Formula Year 2018/19, National Grid has so far received validation reports for 50 sites, which are in the process of review. Three sites have been contacted to provide further clarity of the validation results but all other reviewed validations have passed.

National Grid has an annual target to receive and review 100% of meter validation reports. Over the next six months the Meter Assurance team will continue to request and review the remaining meter validation reports and use the data provided to assist with identifying possible causes of UAG. The reports will also inform the preparation of the subsequent meter witnessing programme.

The roll out and uptake of the NGage meter validation app has become a focus area to drive efficiency through the meter validation processes (refer to section 3.4 of the report). By standardising the meter validation process via NGage, the meter owner can easily provide the relevant validation results of their metering systems and collectively National Grid and the asset owners can demonstrate the accuracy of all input and output measurements for the NTS.

3.2 Meter Witnessing

National Grid plans and undertakes an annual meter witnessing programme. This involves National Grid personnel attending metering installations throughout the UK during meter validations to observe and document the testing taking place. This 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.

Figure 8 below provides a summary of the annual meter witnessing programmes for Formula Years 2017/18 and 2018/19. Last year's programme included 17 meter validations that National Grid had selected to visit. Overall, eight sites were witnessed, four sites were missed due to National Grid resources and the remaining five were either cancelled or rescheduled. Improved communication with asset owners along with internal training will drive this year's programme to be on target.

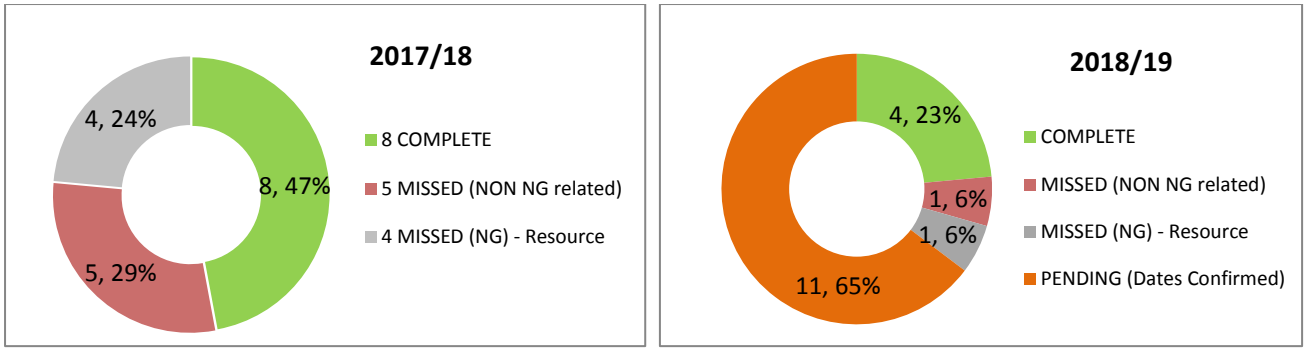

Figure 8: Meter Witnessing Programme Summary – Formula Years 2017/18 and 2018/19

The 2018/19 annual meter witnessing programme also includes 17 metering installations which include gas terminals, power stations, large industrial plants and gas distribution network facilities.

During the March to August 2018 period, National Grid have witnessed four of the six planned meter validations, comprising of a power station, two large industrial sites and a distribution network gas offtake.

Throughout the next six months, National Grid is planning to witness the remaining 11 pending meter validations. Six of these visits have been scheduled over the next three months and National Grid is confident that it should be able to attend the remaining validations included in the 2018/19 annual meter witnessing programme. Recent training and competency assessments have improved resilience within the Meter Assurance team.

3.3 Reconciliation

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

Over the past six months, National Grid has successfully processed 422.84 GWh of reconciliations in absolute energy terms, comprising of 28 instances of reconciliation at individual NTS exit facilities. The reconciliations span a wide range of dates across Formula Years going back to 2015/16. The largest of these reconciliations, which equated to 73.06 GWh was finalised in August 2018 and ranged over four Formula Years, 2015/16 through to 2018/19.

This total quantity reconciled in this six month period is significantly more than what was reconciled over the previous six months, which equates to an increase of 256.44 GWh reconciled.

Figure 9 provides the annual reconciliation quantities, in absolute energy terms, for Formula Years 2014/15 to 2018/19. The red coloured bars indicate the reconciliation quantities successfully processed since the publication of the April 2018 UAG report.

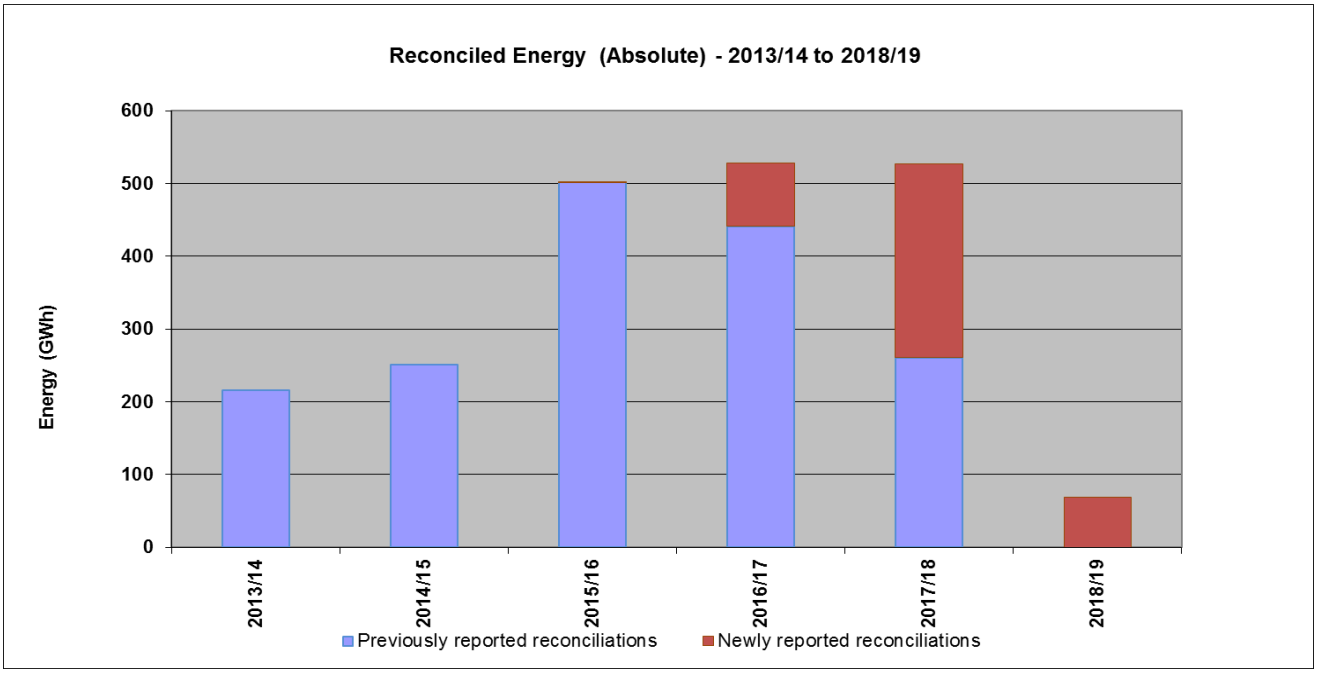

Figure 9: Reconciled energies (absolute) – 2014/15 to 2018/19

Of the 28 instances of reconciliation processed, five related to meter errors, 15 related to validation and system error and eight were due to 3rd party error. The rise in data errors has initiated the development of a new suite of checking tools to assist the daily processes in validating end of day measurements and identifying and mitigating error within the pre-closeout period. Progress will be tracked over the coming months to show how these initiatives have helped reduce the number of reconciliations caused by data error. We are also working with 3rd parties to improve the measurement and allocation process.

A new reconciliation database has also been developed to improve the capture of reconciled data to report and identify trends in measurement error. The database has also enabled National Grid to calculate UAG using corrected reconciled energy as seen in Figure 10. This improvement of corrected data gives an accurate account of UAG after known error has been removed. The outcome of these results will be seen in subsequent reports.

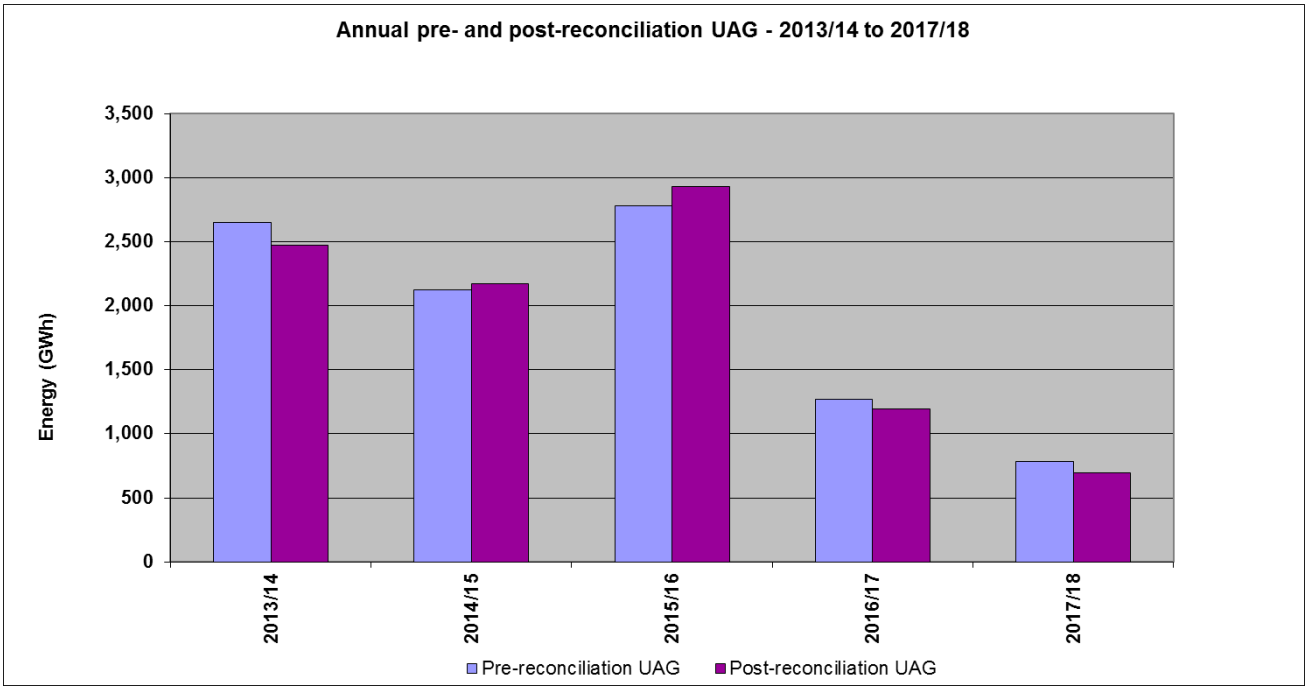

Figure 10: Annual pre- and post- reconciliation UAG – 2013/14 to 2017/18

Figure 10 illustrates that post-reconciliation UAG has the same year on year trend as pre-reconciliation UAG and for three of the five years, post reconciliation UAG has been less. Overall, post reconciliation UAG is less than assessed UAG.

A project has been initiated to capture all sites that frequently experience telemetry and data faults which create the requirement for reconciliation. These sites are currently being investigated to identify the root cause and the actions required to mitigate the errors.

More than half (53%) of the outstanding 33 reconciliations featured in the April 2018 UAG report have been processed over the past six months. A total of 38 data and meter reconciliations are currently being progressed. These will be included in future UAG reports. The remaining energy adjustments are estimated to account for over 107 GWh of reconciled energy in absolute terms.

National Grid continues to review and monitor the data error reconciliations that have been received to improve its understanding of the causes of error and allow for mitigations to be introduced. Figure 11 provides a breakdown of the identified causes of these data error reconciliations over the last 12 months (September 2017 to August 2018).

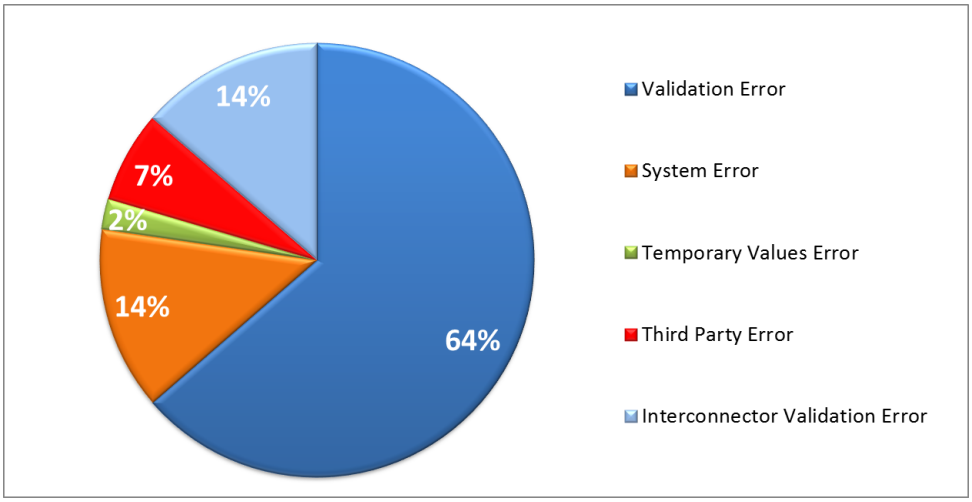

Figure 11: Breakdown of causes of data error reconciliations processed during September 2017 to August 2018 period

Over the last 12 months, 45 (76%) of the 59 reconciliations received were accountable to data error.

Figure 11 indicates three principal causes of data error reconciliations, errors that are introduced during the validation of end of day measurements, system issues concerned with both the Gas Control Suite (GCS) and Gemini and validation errors at Interconnector points. To help moderate the requirement of reconciliation for these types of error, National Grid have made the following improvements:

- A suite of tools has been developed using Tableau that can identify input and system data anomalies and overall completeness of data within the daily validation of end of day measurements. This will help address the data quality challenges being experienced and allow for amendments to be made within the pre-closeout period.
- An initiative to increase awareness of National Grid's allocation processes with Shippers that are affiliated with Interconnector points was launched in April 2018. This educational piece has been successfully received by Shippers and so far, there has not been any further requirement to reconcile misallocated energy at these sites.
- Processes have also been improved to mitigate Gemini B2B layer failures, which is the exchange of data from and to Gemini, that have historically impacted the allocations at Interconnectors.

These new initiatives will be monitored over the coming months to assess the impact on reconciliation and assessed UAG.

The reconciliation database along with new Tableau analysis tools have enabled the detail of each error since 2013 to be assessed. These categorised errors have initiated a project to capture sites

that have ongoing telemetry and data issues which have resulted in multiple reconciliations over extended periods of time. National Grid plans to carry out analysis to identify the source and implement solutions to correct these errors.

National Grid will continue to reconcile as much energy as possible and provide greater detail in future reports of its impacts on UAG.

3.4 NGage Meter Validation Application

NGage is a free to use meter validation application for use on iOS or Android devices which has been developed by National Grid. The app is now available to all meter owners and third party organisations that carry out metering validation activities on the metering systems that are directly connected to the NTS. NGage has been designed to facilitate the collection of meter validation data, in accordance with the current meter validation standard (T/PR/ME/2), and provision of this information to National Grid. The application will automatically upload the results of meter validations to a secure data portal which will enable improved analysis of these results which will be available to both National Grid and the meter owner. A separate gas property and flow calculator called NGageCALC is also available to freely download via the iTunes App Store or Google Play Store.

Since April 2018, NGage has been made available to meter owners with the responsibility of 78% of sites. National Grid can track who has received the app and what sites are expected to publish future validations via the NGage Portal via its roll out plan. Feedback can be captured to support any updates that may improve the use of the application. The opportunity of the value added to both National Grid and the customer will also be captured as more users utilise the app. National Grid will support meter owners using this application during their meter validations. Comprehensive user guides have been developed to assist with the set up and use of both the app and the portal.

A gas distribution network has trialled the app whose meter validations are now being received via the portal. Feedback received so far has been positive and has initiated further enhancements in a future release of the app, a scope document is currently being developed.

National Grid's aim is to make the application available to all meter owners by the end of this Formula Year.

3.5 Baseline UAG Analysis

An independent assessment of the baseline level of UAG, which could be expected from the network operating under normal measurement uncertainties, has been undertaken by Manchester University's mathematics department. The PhD student, appointed under a National Grid sponsored ICASE (Industrial Cooperative Awards in Science and Technology) award, commenced this assessment in October 2016. As discussed in section 2 of this report, National Grid currently uses UAG baseline values of ±20 GWh as a trigger to investigate potentially high levels of positive or negative UAG. This study is expected to provide a more dynamic UAG baseline quantity which will assist in the future management of UAG. It is also expected to provide a range of improved mathematical methods for identifying potential causes of UAG.

During January 2018, the PhD student spent a month with National Grid to further develop the prototype of an application that can undertake change point analysis on the assessed UAG values which are published on the National Grid website. The application was developed on Shiny, an open source R statistical computing package.

It has been identified through testing of the prototype that the current change point analysis techniques when used in isolation does not identify error to the level of detail that National Grid would require. The PhD student is considering the addition of further analytical techniques to support the work already carried out. These include further change point methodologies alongside other algorithms to detect error. The PhD student will spend his second internship with National Grid in early 2019 which will enable the further testing of this prototype application.

It is intended that this app will be used for investigating periods when high levels of positive or negative UAG are observed.

3.6 Ongoing Development of Gas Control Suite

At the end of July 2016 National Grid implemented its new Gas Control Suite system which is used to control the physical and commercial operation of the NTS. One of the roles of GCS is to facilitate the validation of end of day NTS input and output measurements which are transferred to the Gemini customer billing system. GCS also calculates the energy balance for the NTS which is used to manage assessed NTS shrinkage and UAG quantities.

The Meter Assurance team has developed a suite of new data visualisation dashboards to assist the identification of causes of UAG. This has involved the use of Tableau data visualisation software, one of the components of GCS. These Tableau dashboards are being used to compare site flow patterns with UAG behaviour and the completeness and accuracy of data.

Investigations have been made to identify patterns and correlation of UAG with the top 60 sites (based on their annual gas throughput) over the past five years. Figure 12 indicates that the energy for the top 60 sites has increased marginally over the five year period although UAG has fallen.

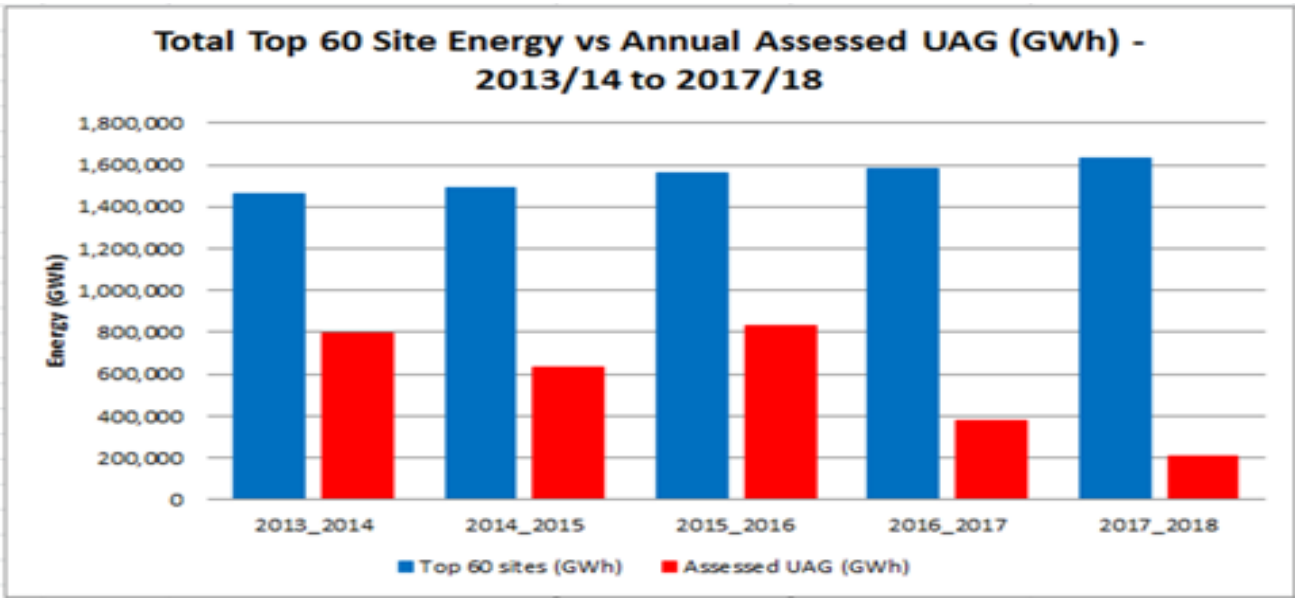

Figure 12: Tableau dashboard - Total Top 60 Site Energy vs Annual Assessed UAG (GWh) – 2013/14 to 2017/18

So far analysis has been carried out at site entity, with no obvious fluctuation in behaviour yet detected, as represented in figure 13. Further research is being carried out to look for correlation at individual site level.

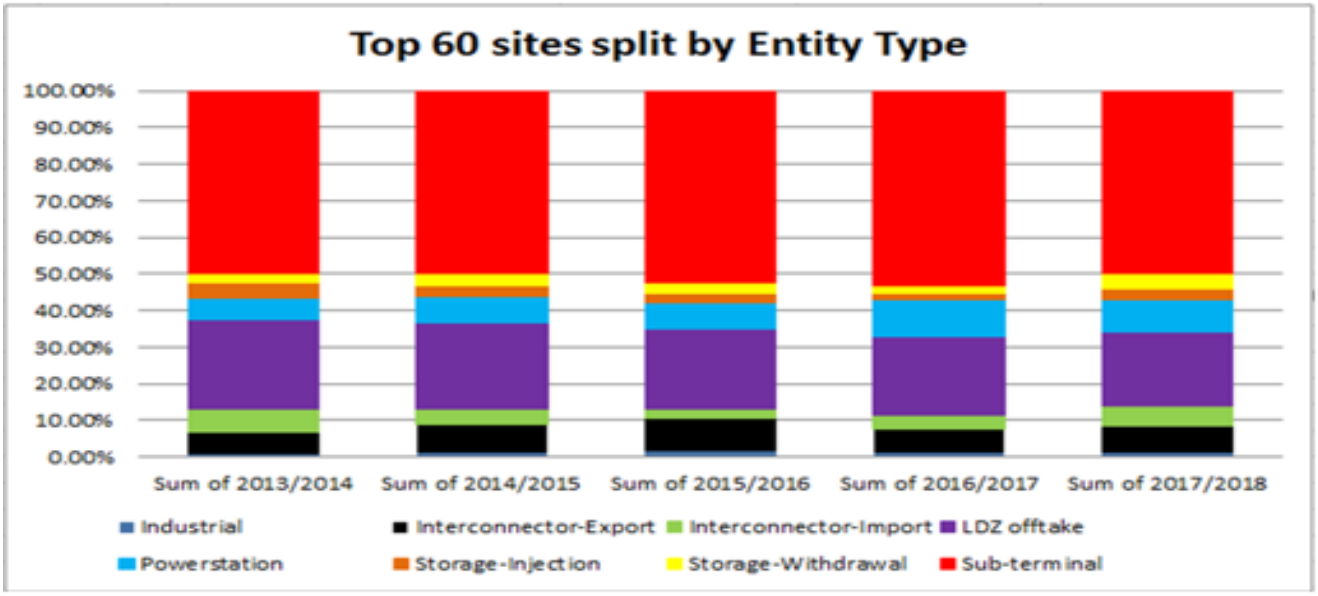

Figure 13: Tableau dashboard - Top 60 sites split by Entity Type

Figures 14 and 15 provide examples of Tableau dashboards that have been deployed to detect causes of UAG.

Energy Completeness checks

GAS_DAY: 05/09/2018

SITE TYPE	GAS_DAY	Expected Number of Inputs	Actual Number of Inputs	% Energy Inputs Complete
Compressor	05/09/2018	25	25	100.00
Industrial	05/09/2018	19	19	100.00
Interconnector-Export	05/09/2018	6	6	100.00
Interconnector-Import	05/09/2018	8	8	100.00
Powerstation	05/09/2018	63	63	100.00
Storage-Boil Off	05/09/2018	2	2	100.00
Storage-Injection	05/09/2018	10	10	100.00
Storage-OUG	05/09/2018	10	10	100.00
Storage-Reject	05/09/2018	1	1	100.00
Storage-Withdrawal	05/09/2018	10	10	100.00
Sub-terminal	05/09/2018	19	19	100.00

Figure 14: Tableau dashboard visualising energy completeness by site entity

Figure 14 illustrates a dashboard which can be used within the close out period to assure the completeness of end of day measurement data for each site type. This dashboard is effective in identifying missing end of day measurements for system inputs and outputs allowing data errors to be corrected within the closeout period. The suite of dashboards also includes these same principles for volume and CV.

Terminal EoD Energy (kWh)

select a gas day

NTS_FUNCTION_NAME	GAS_DAY	NOMS	NOTIFS	SCADA	FUSION	MIPI	% Diff FUSION vs NOMS	% Diff FUSION vs NOTIF	% Diff FUSION vs SCADA	% Diff FUSION vs MIPI
		137,244,708	139,427,400	139,548,528	139,548,528	139,548,528	1.65	0.09	0.00	0.00
		140,044,128	135,570,417	140,147,222	140,147,222	140,147,222	0.07	3.27	0.00	0.00
		79,142,022	79,442,917	78,794,361	78,794,361	78,794,361	0.44	0.82	0.00	0.00
		0	0	0	0	0	0.00	0.00	0.00	0.00
		17,177,595	18,136,800	17,225,556	17,399,278	17,399,278	1.27	4.24	1.00	0.00
		0	0	0	0	0	0.00	0.00	0.00	0.00
		55,000,000	55,550,000	54,944,444	54,936,112	54,936,112	0.12	1.12	0.02	0.00
		65,411,713	69,300,000	65,506,667	65,505,166	65,505,166	0.14	5.79	0.00	0.00
		175,464,264	175,598,718	181,133,333	175,641,559	175,641,559	0.10	0.02	3.13	0.00
		0	0	0	0	0	0.00	0.00	0.00	0.00
		0	0	0	0	0	0.00	0.00	0.00	0.00
		0	0	0	0	0	0.00	0.00	0.00	0.00
		0	0	0	0	0	0.00	0.00	0.00	0.00
		209,946,144	207,500,000	209,888,752	209,888,752	209,888,752	0.03	1.14	0.00	0.00
		234,629,478	237,710,000	236,699,111	236,699,111	236,699,111	0.87	0.43	0.00	0.00
		309,616,052	313,764,765	309,549,479	309,549,479	309,549,479	0.02	1.36	0.00	0.00
		48,647,684	49,060,000	49,044,444	49,113,611	49,113,611	0.95	0.11	0.14	0.00
		111,624,108	110,976,250	111,488,889	111,475,556	111,475,556	0.13	0.45	0.01	0.00
		0	0	0	0	0	0.00	0.00	0.00	0.00

Figure 15: Improved tableau dashboard highlighting differences between nominations, notifications, telemetered measurements, GCS and measurements published in MIPI

Figure 15 displays a dashboard which compares the end of day energy provided by the shippers' nominations, site notification quantities, telemetered end of day measurement received via National Grids SCADA system, GCS measurement data and the validated Gemini end of day measurement that is published on the National Grid Website. This dashboard allows National Grid to identify differences between the values received from multiple sources with the values used for calculating assessed UAG. This dashboard is proving effective by identifying errors during the validation of the provision of end of day measurements into Gemini and highlighting any metering or telemetry issues, allowing for data errors to be corrected within the closeout period.

The Tableau dashboards developed to date are still being utilised to investigate the causes of negative UAG that have been experienced since December 2016. The dashboards will help further analysis to detect possible correlations between individual site flow patterns and UAG behaviour.

National Grid continues to work with GCS and Gemini support teams to ensure that measurement data is passed from GCS to Gemini accurately.

4. Conclusion

The total assessed UAG quantity for the March to August 2018 period is less than for the previous six month period. In addition, total monthly assessed UAG values have been predominantly less than the long-term average (April 2013 to August 2018) monthly assessed UAG.

It is expected that for Formula Year 2018/19 annual assessed UAG will be less than for Formula Year 2017/18 which supports the decline in annual quantities observed since 2009/10. Despite the decline in annual assessed UAG, National Grid is expecting to process a greater quantity of meter or data error reconciliation in absolute energy terms for 2018/19 than what was reconciled for 2017/18.

Improvement of National Grid's analytical ability through the deployment of improved data visualisation tools continues to support its ongoing work into the investigation of the causes of UAG. This is assisting National Grid to identify and correct data errors during the pre-closeout period.

Continued support from meter owners has enabled National Grid 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 and to inform the preparation of future meter witnessing programmes.

Appendix I - National Grid Gas Plc (NTS) Gas Transporter Licence Special Condition 8E

Special Condition 8E: Requirement to undertake UAG Projects to investigate the causes of Unaccounted for Gas (UAG)

Introduction

8E.1 The purpose of this condition is to set out the obligations of the Licensee in respect of undertaking projects for the purposes of investigating the causes of Unaccounted for Gas (UAG) and the publication of the findings of these projects, including relevant data.

Part A: Licensee's obligations under this condition

8E.2 The Licensee shall use reasonable endeavours to undertake the UAG Projects as specified in this condition for the purposes of investigating the causes of Unaccounted for Gas in respect of Formula Year t commencing on 1 April 2013 and each subsequent Formula Year t until 31 March 2021. The UAG Projects shall include but need not be limited to those set out in paragraph 8E.5. Where the Licensee does not undertake certain UAG Projects it shall clearly set out its reasoning in the UAG Reports referred to in paragraph 8E.3.

8E.3 The Licensee shall publish UAG Reports of the findings of these UAG Projects on its website and provide a copy of the UAG Reports to the Authority. The Licensee shall publish the UAG Reports by 1 May 2013, 1 October 2013 and every subsequent six months thereafter or such other dates as agreed by the Authority.

8E.4 Within one month of publishing a UAG Report the Licensee shall publish on its website all the relevant data referred to in the UAG Report. Where there are legitimate reasons for not publishing certain data on the website the Authority may consent for the Licensee not to do so.

Part B: Interpretation

8E.5 For the purposes of this condition:

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.

UAG Report	means the report of the findings of the UAG Projects undertaken by the Licensee. The UAG Report shall detail the UAG Projects the Licensee has undertaken in the previous period, the UAG Projects it proposes to undertake in the next period and the Licensee's 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. The UAG Report shall also detail the reasons why any UAG Projects that the Licensee proposed to undertake have not been undertaken. The UAG Report shall summarise any relevant discussion concerning UAG at industry fora and with interested parties on a one-to-one basis.
Unaccounted for Gas (UAG)	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 network code.
Measurement Equipment; NTS System Entry Points; Supply Meter Installations; NTS Exit Points; Entry Close-out Date; NTS Shrinkage	shall bear the same meanings as are given to those terms in the network code.

Appendix II – Relevant data referred to in October 2018 Unaccounted for Gas Report

This appendix provides the relevant data used to prepare the figures and tables provided in the report. The assessed and estimated UAG, OUG and CVS values used in the figures and tables are calculated from daily assessed values published on the National Grid website.

Figure 1:

Formula Year	Annual assessed UAG (GWh)	2018/19 UAG Estimate (GWh)
2013/14	2,648	-
2014/15	2,121	-
2015/16	2,782	-
2016/17	1,272	-
2017/18	783	-
2018/19	202	280

The annual assessed UAG for 2018/19 covers the period 1st April to 31st August 2018.

Figure 2:

Month	Total monthly assessed UAG (GWh)	Average monthly assessed UAG (GWh)	Average Yearly UAG (GWh)
Apr-13	337.54	150.89	220.67
May-13	220.69	150.89	220.67
Jun-13	266.17	150.89	220.67
Jul-13	283.19	150.89	220.67
Aug-13	72.18	150.89	220.67
Sep-13	186.56	150.89	220.67
Oct-13	184.75	150.89	220.67
Nov-13	254.88	150.89	220.67
Dec-13	193.15	150.89	220.67
Jan-14	235.28	150.89	220.67
Feb-14	210.38	150.89	220.67
Mar-14	203.22	150.89	220.67
Apr-14	150.50	150.89	176.77
May-14	200.90	150.89	176.77
Jun-14	197.26	150.89	176.77
Jul-14	284.19	150.89	176.77
Aug-14	197.98	150.89	176.77
Sep-14	256.67	150.89	176.77
Oct-14	223.58	150.89	176.77
Nov-14	154.41	150.89	176.77
Dec-14	179.73	150.89	176.77

Month	Total monthly assessed UAG (GWh)	Average monthly assessed UAG (GWh)	Average Yearly UAG (GWh)
Jan-15	84.50	150.89	176.77
Feb-15	81.31	150.89	176.77
Mar-15	110.23	150.89	176.77
Apr-15	70.99	150.89	231.85
May-15	153.27	150.89	231.85
Jun-15	84.29	150.89	231.85
Jul-15	209.38	150.89	231.85
Aug-15	437.92	150.89	231.85
Sep-15	283.13	150.89	231.85
Oct-15	313.53	150.89	231.85
Nov-15	431.57	150.89	231.85
Dec-15	296.88	150.89	231.85
Jan-16	183.12	150.89	231.85
Feb-16	120.94	150.89	231.85
Mar-16	197.22	150.89	231.85
Apr-16	126.71	150.89	105.97
May-16	185.70	150.89	105.97
Jun-16	138.06	150.89	105.97
Jul-16	148.50	150.89	105.97
Aug-16	354.84	150.89	105.97
Sep-16	214.48	150.89	105.97
Oct-16	119.22	150.89	105.97
Nov-16	39.19	150.89	105.97
Dec-16	-48.90	150.89	105.97
Jan-17	-71.07	150.89	105.97
Feb-17	-78.32	150.89	105.97
Mar-17	143.26	150.89	105.97
Apr-17	116.39	150.89	65.22
May-17	71.05	150.89	65.22
Jun-17	1.97	150.89	65.22
Jul-17	118.93	150.89	65.22
Aug-17	98.25	150.89	65.22
Sep-17	130.88	150.89	65.22
Oct-17	-15.13	150.89	65.22
Nov-17	-23.71	150.89	65.22
Dec-17	15.68	150.89	65.22
Jan-18	-35.96	150.89	65.22
Feb-18	74.70	150.89	65.22
Mar-18	139.41	150.89	65.22
Apr-18	147.69	150.89	40.35
May-18	8.76	150.89	40.35
Jun-18	-78.32	150.89	40.35
Jul-18	70.19	150.89	40.35
Aug-18	53.42	150.89	40.35

Monthly Assessed UAG – April 2013 to August 2018

Figure 3:

April 2018	June 2018
26.02	19.80
25.74	15.74
23.56	12.60
23.42	10.53
19.41	10.50
16.97	10.23
16.45	9.95
14.01	9.02
11.48	4.09
9.59	3.27
9.03	2.51
8.88	2.49
7.31	2.43
6.79	2.43
5.20	2.19
5.05	-0.62
4.50	-1.52
3.98	-4.80
3.62	-9.02
3.25	-11.04
2.91	-12.20
-2.98	-12.64
-4.86	-12.90
-5.49	-13.30
-8.17	-17.15
-10.84	-18.65
-15.12	-18.68
-15.66	-19.08
-16.69	-21.91
-19.67	-22.60

Daily Assessed UAG Ranked from Highest to Lowest – April 2018 and June 2018

Figure 4:

Month	Total monthly assessed UAG (GWh)	Month	Total monthly assessed UAG (GWh)
Mar-17	143.26	Mar-18	139.41
Apr-17	116.39	Apr-18	147.69
May-17	71.05	May-18	8.76
Jun-17	1.97	Jun-18	-78.32
Jul-17	118.93	Jul-18	70.19
Aug-17	98.25	Aug-18	53.42

Monthly Assessed UAG – March to August 2017 and March to August 2018

Figure 5:

Daily assessed UAG values are published on the National Grid website via the following link: https://www.nationalgridgas.com/balancing/unaccounted-gas-uag

The upper and lower baseline UAG quantities provided in Figure 4 are respectively +20 GWh and -20 GWh.

Figure 6:

Month	Total monthly assessed UAG (GWh)	Month	Total monthly assessed UAG (GWh)
Apr-16	126.71	Apr-17	127.90
May-16	185.70	May-17	78.61
Jun-16	138.06	Jun-17	15.36
Jul-16	148.50	Jul-17	132.28
Aug-16	354.84	Aug-17	105.24
Sep-16	214.48	Sep-17	137.78
Oct-16	119.22	Oct-17	-4.39
Nov-16	39.19	Nov-17	-16.22
Dec-16	-48.90	Dec-17	24.17
Jan-17	-71.07	Jan-18	-32.82
Feb-17	-78.32	Feb-18	75.37
Mar-17	143.26	Mar-18	139.41

Monthly Assessed UAG – 2017/18 and 2016/17

Figure 7:

Daily assessed UAG values are published on the National Grid website via the following link: https://www.nationalgridgas.com/balancing/unaccounted-gas-uag

The upper and lower baseline UAG quantities provided in Figure 6 are respectively +20 GWh and -20 GWh.

Figure 8:

Criteria	Witness Schedule 2017/18		Witness Schedule 2018/19	
Complete	8	47%	4	23%
Missed (Non NG related)	5	29%	1	6%
Missed (NG) – Resource	4	24%	1	6%
Pending (Dates Confirmed)	0	0%	11	65%
Future (No Dates Confirmed)	0	0%	0	0%

Meter Witnessing Programme Summary – Formula Years 2017/18 and 2018/19

Figure 9:

Formula Year	Number of instances of reconciliation published in April 2018 UAG report	Reconciled energy (absolute) published in April 2018 UAG report (GWh)	Number of instances of reconciliation processed since publication of April 2018 UAG report	Reconciled energy (absolute) processed since publication of April 2018 UAG report (GWh)
2013/14	45	216.49	0	0.00
2014/15	47	250.71	0	0.00
2015/16	60	501.43	1	0.76
2016/17	117	441.23	5	86.42
2017/18	25	260.69	18	266.77
2018/19	0	0	8	68.89

Reconciled Energies (absolute) – 2014/15 to 2018/19*

*2018/19 covers the period 1st April to 31st August 2018.

Figure 10:

Formula Year	Pre-reconciliation UAG (GWh)	Post reconciliation UAG (GWh)
2013/14	2,648.01	2,471.51
2015/16	2,121.26	2,172.62
2016/17	2,121.26	2,931.52
2017/18	1,271.67	1,193.07
2018/19	782.69	692.30

Annual pre- and post- reconciliation UAG – 2013/14 to 2017/18

Figure 11:

Error Type	Past 12 months Data Reconciliations (SEP 17 to AUG 18)	
Validation Error	28	64%
System Error	6	14%
Temporary Values Error	1	2%
Third Party Error	3	7%
Interconnector Validation Error	6	14%

Breakdown of causes of data error reconciliations processed during September 2017 to August 2018 period