Unaccounted for Gas (UAG) Report

National Grid
Gas Transmission

October 2014

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 Special Condition 8E: Requirement to undertake UAG Projects to investigate the causes of UAG.

If you have any feedback or questions on this document please get in contact with us at:

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Background

This report provides a review of National Grid's Unaccounted for Gas (UAG) management covering the period up to and including the 30th September 2014. All data reported as 2014/15, unless stated, refers to the period 1st April to 30th September 2014 inclusive.

National Grid also provides a range of UAG related data including:

- All the previous UAG reports
- Daily UAG data

which is available at:

http://www2.nationalgrid.com/uk/industry-information/gas-transmission-system-operations/balancing/unaccounted-for-gas

This report discharges National Grid Gas's (NGG's) responsibilities under Gas Transporter Licence Special Condition 8E "Requirement to undertake UAG Projects to investigate the causes of Unaccounted for Gas (UAG)", available via the following link:

https://epr.ofgem.gov.uk

Executive Summary

The underlying levels of NTS Unaccounted for Gas (UAG) have been reducing since 2012 and the behaviour in the 2014/15 period has continued this trend. National Grid is well advanced with their meter witnessing and data analysis programmes in this period and this, in conjunction with the proactive approach of all asset owners to meter husbandry, have been significant contributory factors to the maintenance of this reduction.

While this current downward trend is welcome, National Grid recognised the need to develop a set of initiatives to further enhance UAG management. These initiatives include the development of a holistic Metering Validation and Analysis App and support software which will offer all asset owners a reliable platform to perform the meter validation process, analyse and store the results securely and centrally. Other initiatives to develop innovative techniques that will complement the existing analytical methods have been further developed.

National Grid will continue to increase its engagement with all asset owners by providing more opportunities to enhance these relationships with the aim of ensuring best practice across the full range of NTS meter management.

National Transmission Unaccounted for Gas Trends

1.1 Annual NTS Shrinkage

The annual NTS shrinkage trend since 2008 is presented in Figure 1.

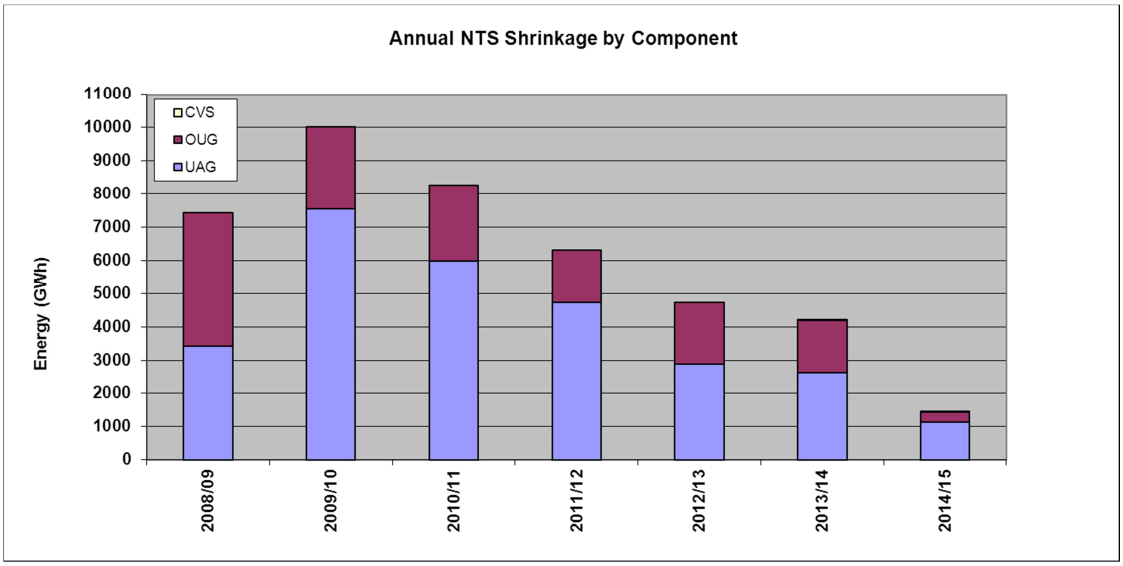

Figure 1: Annual NTS Shrinkage by component since 2008.

The elements of the annual shrinkage trend presented in Figure 1 is summarised as:

- The reduction in Own Use Gas (OUG) due to a combination of changes to underlying supply patterns and increased efficiency in compressor operation.
- Low levels of CV Shrinkage (CVS) with annual levels less than 50 GWh have been a feature of NTS Shrinkage throughout this period.
- Unaccounted for Gas (UAG) levels continue to show year on year reductions, however this trend has been notably impacted by the identification of significant meter errors within this period.

1.2 Unaccounted for Gas

The Unaccounted for Gas (UAG) totals in Figure 1 are presented inclusive of meter error (i.e. assessed) and since 2009, continues to be the major NTS shrinkage component.

While subsequent meter reconciliations reduced the net UAG positions for the 2009/2012 period (see Section 1.3.3), it is the post 2012 behaviour that is considered the most indicative of the fundamental underlying UAG behaviour as it is free of detected meter error. This view is further supported by the fact that all asset owners will have now completed a minimum of three meter validations in this period.

A general set of UAG statistics since 2011 is presented in Table 1. Over this period the observed UAG behaviour has been characterised by reductions in the year on year daily average levels and this trend has continued in to 2014. The April 2014 UAG Report[1] proposed that two further indicators supported the observed reductions being genuine rather than any dominating systematic bias since:

- The standard deviation of the annual values is similar at ~ +/- 20 GWh which is indicative of a consistent volatility around the mean values.
- The similarity of the 'Percentage of NTS Throughput' metric since 2012 suggests that the current assessed UAG levels can be considered baseline values. If this wasn't the case the linkage between daily mean values and standard deviations would show greater distortion.

These observations still hold for the 2014/15 period, although the slight increase in UAG as a 'Percentage of NTS Throughput' is considered more of a function of lower NTS throughputs (demand) rather than any underlying increase in the base levels. This assumption is further supported by the slight reduction in daily average UAG levels during this period.

[1] The April 2014 UAG Report can be found at: http://www2.nationalgrid.com/uk/industry-information/gas-transmission-system-operations/balancing/unaccounted-for-gas

UAG Statistics	2011/2012	2012/2013	2013/2014	2014/15
Assessed Annual Level (GWh)	4737	2894	2472	1207
Daily Average (GWh)	12.941	7.929	7.084	6.821
2σ (Std. Deviation) (GWh)	22.116	19.308	21.516	20.012
Percentage of NTS Throughput	0.45	0.29	0.29	0.32

Table 1: The statistical UAG performance since 2011.

The monthly UAG totals since October 2012 are presented in Figure 2, indicating that the monthly UAG reductions have been largely consistent across this period. For the period October 2012 to September 2013 inclusive, nine (9) months had monthly totals in excess of 200 GWh whereas only five (5) months have exceeded this level since October 2013 to date.

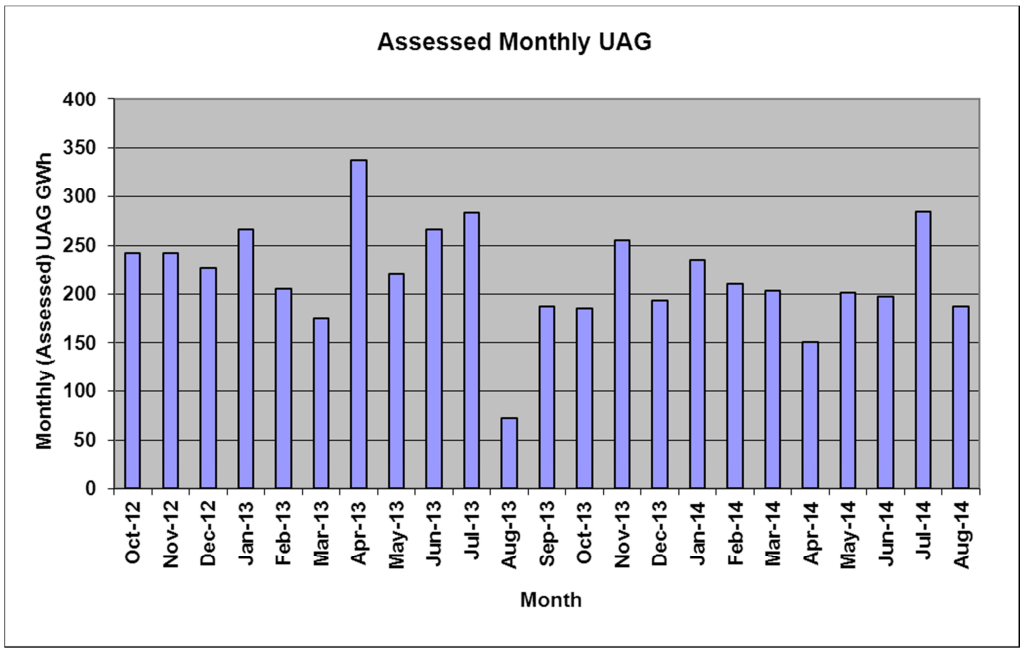

Figure 2: Monthly UAG since October 2012.

1.3 UAG Management Activities

While holistic UAG levels have continued to decline in 2014/15, National Grid is always looking at new techniques that provide new insight and potential mitigation opportunities. The status of these activities is discussed in the sections below.

1.3.1 Meter Witnessing

As part of the continued UAG management, National Grid undertakes an annual meter validation witnessing campaign. This activity is an important part of the continuing engagement between National Grid and the meter asset owners across the NTS network.

The range and number of sites witnessed since 2009 is presented in Table 2.

Year/Site Type	DNO Offtakes	VLDMC	Terminal/ Storage/Interconnectors	Total
2009/2010	25	8	11	44
2010/2011	17	8	7	32
2011/2012	16	6	9	31
2012/2013	16	13	5	34
2013/2014	10	14	5	29
2014/2015	12	3	5	20

Table 2: National Grid's Meter witnessing record.

For 2014 the witnessing campaign has been aligned to the calendar year and its scope and current status is presented in more detail in Table 3.

Site Type	Planned	Completed	Scheduled
Terminals	6	2	4
Storage	2	1	1
Interconnectors	3	2	M
VLDMC			
Third Party	6	3	2
NGGT	3	0	0+2M
DNO			
NGGD	6	5	A
WWU	3	2	A
SGN	3	2	M
NGN	4	3	M
Total	**36**	**20**	**7**

Table 3: Summary of National Grid's 2014 Meter Witnessing Campaign.

Key:

A:- One of the selected sites was being independently audited and thus not witnessed in the 2014 campaign at the request of the DN. In all cases an alternative site was offered.

M:- It was not possible to witness the selected sites due to scheduling (SGN, NGN) or technical difficulties (NGGT).

The 2014 witnessing campaign is now well advanced with the expected schedule to complete 27 out of 36 planned visits. Where it has not been possible to perform a scheduled witness, asset owners have been very proactive in either providing an alternative site or have offered the site for the 2015 campaign.

The level of validation excellence observed has, without exception, been high. There have been no issues with any witnessed validations other than those expected as normal maintenance activities.

There are still slight variations in the range of tests that are performed within the ME2[2] framework but these tend to be due to interpretations and the nature of installed equipment rather than any attempt to undermine the validation process. The main area of deviation in this regard is the testing of the Analogue to Digital conversion (ADC) inputs within the flow computer.

The ADC is the main interface between the field instrument and the flow computer and validation experience indicates that ADC drift is more prevalent in some flow computers than others. This disparity of performance is considered an installation legacy but there is no evidence to suggest that any metering installation is performing outside its required uncertainty (+/- 1.1% on measured energy).

The National Grid meter witnessing campaign is carefully orchestrated to maximise the potential of this activity with site selection being set by clearly defined metrics[3]. Although, it is not feasible or effective to witness the validation at every site, National Grid review all ME2 validation documentation. Again the standard of validation information and test results are high with very few instances of additional information being required.

The witnessing activity is greatly assisted by the proactive response from all asset owners and the strength of these relationships is highly valued. This plays an important role in the general husbandry of UAG.

Despite the undoubted quality of the meter validations that take place across the NTS, consideration has been given to assist in the improvement of the validation data capture and articulation of the results. Hence it is proposed that National Grid will develop a comprehensive and free Meter Validation and Analysis Package, which will consist of a suite of validation software for tablet

[2] ME2 is the National Grid specification for fiscal meter validation. It is defined in National Grid Management Procedure T/PM/ME2 and in the IGEM publication IGE-GM-4 Ed.2 (see Appendix 5)
[3] April 2014 UAG Report Page 7. http://www2.nationalgrid.com/uk/industry-information/gas-transmission-system-operations/balancing/unaccounted-for-gas

and desktop platforms. This proposal and its current status are discussed in more detail in the Future Initiatives Section 1.3.4.1.

1.3.2 UAG Data Analysis

Following a comprehensive review of National Grid's UAG analysis tools[4] it was concluded that only the Power Station Efficiency Tool (PSET) and the Composite Weather Variable (CWV) offered sufficient dynamic response to be of benefit in the timely and efficient management of UAG. Development and improvement of the data handling capability of these tools and their automation or semi automation to reduce processing time and improve result clarity has been on going. This work is nearing completion with both tools now operational and undergoing detailed evaluation.

To assist the focus of the UAG tools, numerous attempts have been made to provide a more dynamic view of UAG behaviour. The inherent volatility of day on day UAG makes any statistical metrics very problematic. This can mask shifts in underlying trends and thus in an attempt to remove the influence of volatility, an alternative ranking technique is being evaluated.

This technique orders daily UAG for each month solely in terms of magnitude. The resulting chart for 2014/15, excluding September 2014, is presented in Figure 3.

[4] April 2014 UAG Report Pages 9-12 inc. http://www2.nationalgrid.com/uk/industry-information/gas-transmission-system-operations/balancing/unaccounted-for-gas

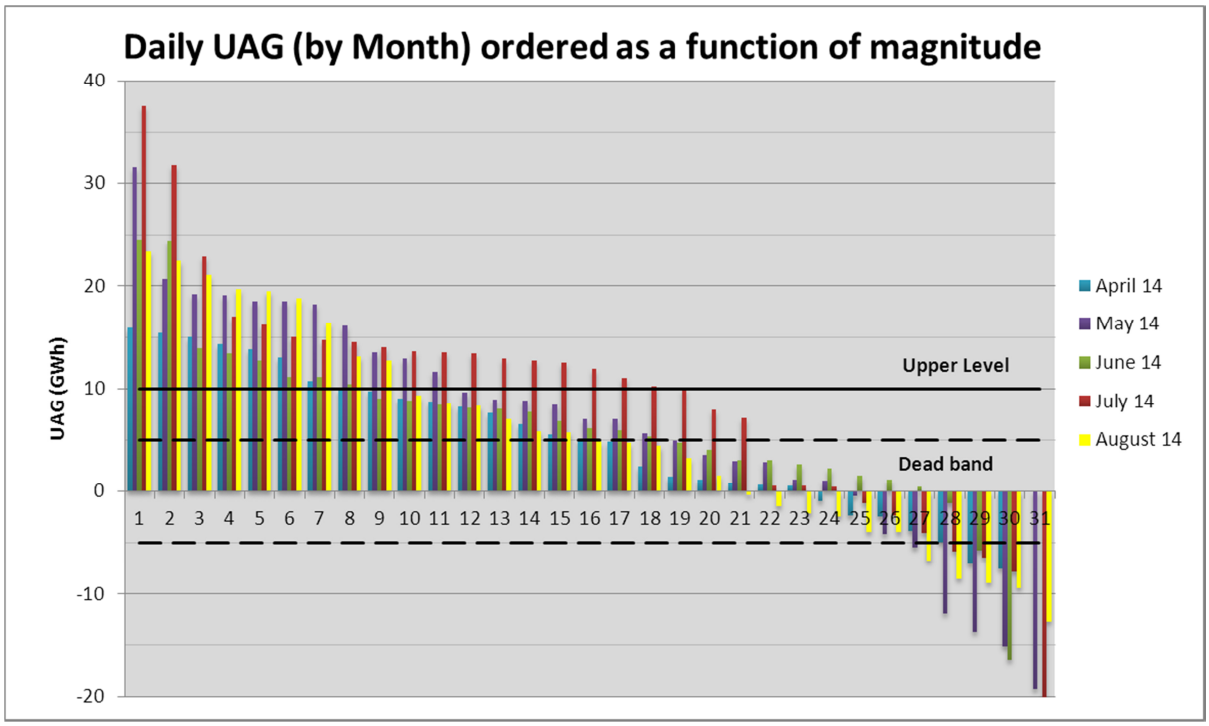

Figure 3 Daily UAG sorted by magnitude per month

By ignoring the sequential daily UAG values and only ordering in terms of magnitude (Figure 3) readily highlights month on month variations. This approach allows the definition of a 'Dead band' (between the dotted lines in Figure 3) of UAG as the number of days within the month between a particular range. The choice of the 'Dead band' is arbitrary and is not necessarily symmetric about the mantissa (UAG zero line) although the proposed Baseline mathematical study (See Future Initiatives Section 1.3.4.2) will feed into this approach and assist in the definition of the Dead band and Upper Level.

The Upper Level metric is set to provide an indicator of levels of UAG (currently positive) that are considered above the normally expected magnitudes. The number of days in a month, and their distribution are seen as indicators of both data quality and or meter based issues.

Initial analysis has used a dead band of +/-5GWh and is summarised in Table 4.

Days	April 14	May 14	June 14	July 14	August 14
Upper Level >10 GWh	7	11	8	18	9
Within +/- 5GWh Dead band	12	8	10	6	11
< -5 GWh	2	4	2	3	4

Table 4 Summary of the Dead Band UAG Analysis.

The dead band analysis for the 2014/15 period highlights July 2014 as being significantly at variance with the period to date with 18 days having UAG in excess of 10 GWh. This has focused initial investigations which are currently on going.

Following the dead band analysis it is possible to focus the Power Station Efficiency Tools and the Composite Weather Variable analyses. The results from these analyses is still being evaluated but will form part of National Grid's Distribution Network liaison activities and where appropriate with individual asset owners.

1.3.3 Meter Reconciliation

National Grid is obligated to process all NTS related meter error reconciliations for the community to ensure financial equality between the Shrinkage Provider (NGGT) and the shipping community. While a defined net UAG position will be subject to meter error detection within the reconciliation window[5], it does provide a further key indicator as to the underlying base UAG trend. Although the reconciliation process is a solely financial readjustment, it is still possible to

[5] On 1st of April 2014, exit (demand) meter reconciliation will be only permissible within a rolling 3/4 year period (as per UNC Modification 398) down from the previous rolling 4/5 year reconciliation period.

present a consequential net annual UAG energy figure. These are presented for the financial years since 2009 in Table 5.

Care must be taken in using the absolute number of meter reconciliations reported each year as a true UAG indicator because a single error can be of significant magnitude. Nevertheless, the reduced volume of meter reconciliations and reduced UAG levels are considered the result of improved asset management.

National Grid is committed to processing meter error reports (MERs) as efficiently and expediently as possible. The current MER status is such that the figures presented in Table 5 can be considered highly representative of the true historical view of UAG over the period.

Year	Annual No of Reported Meter Errors	Assessed UAG (GWh)	Net Energy Reconciled (GWh)	Net UAG (GWh)
2009/2010	81	7551	-3178	4373
2010/2011	48	5996	-1259	4737
2011/2012	52	4737	52	4789
2012/2013	52	2894	-151	2743
2013/2014	33	2472	19	2491
2014/2015	27	1207	14	1221

Table 5: Meter Reconciliation Statistics inclusive of UAG Net of Meter Error.

1.3.4 Future Initiatives

While the existing UAG analysis tools are beginning to highlight analysis areas there are still other areas of UAG management that require alternative approaches. This will not only provide unequivocal evidence of meter

management performance but also provide indicators for potential areas for future investment. The set of current proposals and their respective status is presented below:

1.3.4.1 Meter Validation App

- A programme has been proposed to develop a comprehensive Meter Validation and Analysis App that will be available for mobile platforms (iOS and Android). The Validation App will be freely available to all NTS connected parties facilitating the collection of appropriate meter validation data in accordance with the ME2 standard. MVAT will provide a secure storage and analysis platform for each user.

  The validation software will simultaneously perform the necessary gas property calculations (ISO 6976, AGA8, AGA10) and flow equations (ISO 5167, ISO 9951) as necessary during the data collection. The application will also provide a detailed review of the meter performance in terms of the individual validation test tolerances. Upon completion of the validation, the data will be automatically uploaded to a dedicated secure server. The App will provide a holistic validation data collection platform enabling efficient offline data analysis for National Grid (whole data set) and for each registered asset owner (own data set).

  Status:

  The Meter Validation App proposal has been granted provisional Network Innovation Funding (NIA) to begin in early 2015. Further engagement with end users is being conducted to ensure that the delivered functionality is compatible with asset owner's requirements and a final decision will be made before the end of 2014.

1.3.4.2 Baseline UAG Analysis

- It is proposed to develop an independent assessment of the Baseline level of UAG that could be expected from the network operating under normal measurement uncertainties. This independent study will enable National Grid to quantify UAG in terms of this baseline that will assist in the future

management of UAG. The determination of a baseline will enable a better definition of the Dead band presented in Figure 3.

This Baseline analysis will be combined with the development of other mathematical techniques outside the statistical approaches already employed, such as matrix and dynamical mathematical techniques. These approaches will be confined to producing a set of techniques that will complement the existing UAG analysis already undertaken.

Status:
Initial Research Departments have been highlighted. National Grid will now define the scope of programmes with prospective candidate universities.

1.3.4.3 On-Line Network Modelling

- The opportunity to utilise National Grid's on line network tool, SIMONE, to provide early indications of flow discrepancies.

Status:
A full review of the on-line SIMONE tool have been conducted, including discussions with Liwacom[6]. The use of on-line data will commence a set of calibration exercises shortly and will add to the existing range of dynamic tools being employed to highlight UAG discrepancies.

2. Summary

The underlying levels of NTS UAG are still appearing to be reducing. While it is not possible to fully determine the rate of decline from just the Q1 and Q2 2014 figures, daily average figures are indicative of continued reduced levels. It is still not possible to define any one unique cause for this reduction. However the proactive approach of all asset owners to meter husbandry in conjunction with National Grid's concerted witnessing, data analysis and reconciliation activities are considered strong contributing factors.

[6] Liawcom Informationstechnik GmbH is the marketing and research development for the SIMONE network modelling tool.

To enhance National Grid's management of UAG, further refinement of the Power Station Efficiency Tool (PSET) and Composite Weather Variable (CWV) analysis have been complimented by the introduction of the UAG magnitude assessment analysis.

Subsequently, a set of initiatives to develop alternative techniques that will support the existing analytical methods has been proposed. These alternative approaches are now nearing final scoping and sanctioning. The Meter Validation and Analysis App will offer a comprehensive, network wide validation capability. This unique but tailored offering will enable asset owners across the NTS to provide detailed meter validation data with associated analysis. This will not only provide unequivocal evidence of meter management performance but also provide indicators for potential areas for future investment.

UAG management is multi-faceted and relies on the widespread expertise of technicians, engineers and managers across the asset owner community. The recent reductions in UAG bear testament to the continued high levels of commitment by all concerned with gas transmission measurement.

National Grid continues to broaden its engagement with all asset owners and will further enhance this activity by providing more opportunities and would always welcome any feedback[7] related to UAG management.

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