UIG Calculation Issue - Analysis

This document is from the AUG Expert in response to an industry request for support in understanding the high levels in UIG and the day to day volatility.

Overview

Mod 432 introduced several changes to the balancing regime, in particular the introduction of reconciliation for all meter points and the calculation of daily UIG – a balancing figure which is then allocated to shippers based on a table of weighting factors provided by the AUG Expert.

The current approach to the calculation of daily UIG contains a key weakness that results in very high levels of variation in the day to day estimate, in addition to UIG with an unrealistically high order of magnitude.

The central issue is the fact that up until all meter reads have been received and reconciled, the UIG calculation mixes actual load data (LDZ intake and daily metered load) with estimated load data (using the NDM allocation algorithm). UIG is then calculated as the difference between the actual LDZ intake and the DM (metered) and NDM (estimated) loads.

As a result of this, the difference figure labelled as UIG actually contains error due to the inaccuracy of the NDM algorithm. This error is the cause of the large magnitude and the volatility of the values that are being returned. This is shown in Figure 1. The left side of the diagram shows the pre-Nexus situation where the Scaling Factor (SF) accounted for both the Unidentified Gas (UG) and the error in the allocation algorithm. Post-Nexus, UIG is made up of both UG and the NDM algorithm error as SF has now been removed.

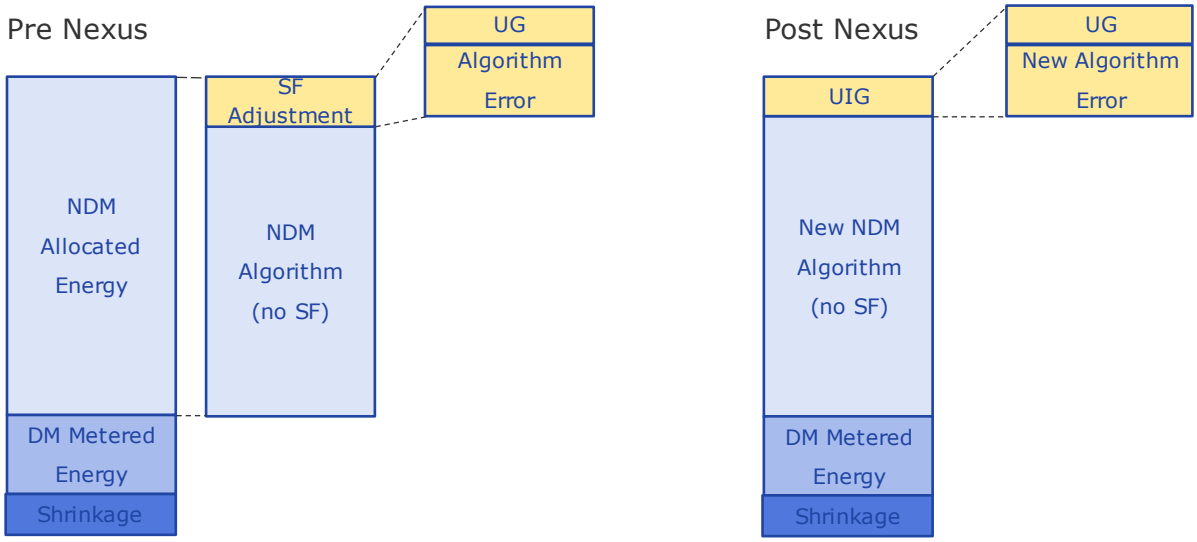

Figure 1: Explanation of 'Algorithm Error'

Over time, as meter reads are received, the reconciliation process will remove the algorithm error as estimated consumption values are replaced with actuals. However, given current meter read frequencies, an accurate estimate of UG will not be obtained until at least a year after initial UIG calculation.

The Problem

The name UIG suggests that the balancing figure represents Unidentified Gas, i.e. the total figure estimated by the AUG Expert. This is **not** the case, however, as the two represent different things. UIG is a daily figure rather than an annual one, and is calculated by subtracting shrinkage, metered DM demand and NDM allocations from the total LDZ intake. The issue here is that the NDM allocations are essentially forecasts of NDM demand based on a version of the NDM profiling algorithm. These forecasts are subject to error, as with any other forecasting model.

It is known from DNV GL's work as the AUGE that UG is a stable figure of approximately 1% of throughput, a figure that has remained relatively stable throughout the AUGE period. The most recent estimate available, from the AUG Statement for 2017/18, put the overall level of Unidentified Gas at 1.1% of throughput.

It should be borne in mind that these Unidentified Gas figures are calculated independently at an annual rather than a daily level, using far more sophisticated data and methods than the daily UIG calculation. These methods are described in detail in the AUG Statement. UIG, which is intended to be a daily estimate of the level of Unidentified Gas, is calculated using methods defined in Mod 432, and has been shown since Nexus go-live to return very different and unreliable results.

The most recent figures we have seen show that the daily Mod 432 calculation returned an average UIG figure of approximately 7% of throughput for September, with a peak of nearly 15% for the national UIG total. UIG for individual LDZs is even more variable and ranged between -16.9% and 23.9% of throughput.

These figures are clearly not credible: negative UG of this magnitude is not physically possible, whilst it is equally implausible that 24% of throughput on a given day is lost to Unidentified Gas. It is clear, therefore, that the current UIG calculation is not fit for purpose, and a solution must be found to ensure that it returns accurate and consistent values that reflect the true level of Unidentified Gas.

As stated above, the large amount of variation in the UIG estimates calculated using Mod 432 techniques is a result of the formula mixing actual values (LDZ intake and daily metered load) with allocations (Product Class 3 and 4 load) in the UIG equation:

> *UIG = LDZ Throughput – Shrinkage – Metered Demand (Products 1 & 2) – Allocated Demand (Products 3 & 4)*

This calculated difference figure is **not** Unidentified Gas: it is Unidentified Gas *plus* allocation algorithm error.

Pre-Nexus, the NDM profiling algorithm (see equation below) was used on an LDZ by LDZ basis to calculate an allocation for each EUC. The algorithm included a Scaling Factor (SF) which scaled all allocations to ensure that the total LDZ allocation matched the total LDZ demand.

Used in this manner, the profiling algorithm was splitting the total LDZ demand between EUCs. This is the purpose for which the algorithm was intended. Used in this way, there is no real requirement for the algorithm to give an accurate forecast by EUC, merely to get the relative proportions of demand from each EUC correct.

$$Alloc^{EUC} = AQ^{EUC} * ALP^{EUC} / 365 * (1 + DAF^{EUC} * WCF^{LDZ}) * SF^{LDZ}$$

The profiling algorithm excluding the SF can be thought of as a bottom-up forecast of the NDM demand as shown in Figure 1 (the diagram shows the algorithm under-forecasting so SF in

this case is greater than 1, but the algorithm could also over-forecast resulting in SF<1). This bottom-up forecast has an inherent 'algorithm error' associated with it. The SF can be thought of as a correction to allow for this algorithm error and UG.

Post-Nexus, the SF has been removed from the NDM algorithm altogether. There are also some other, more minor changes to the algorithm in the way it uses CWV, but essentially it operates in the same way. As a result, the UIG amount calculated under Nexus includes both UG and the algorithm error.

Algorithm Error Analysis

The key to this issue is the magnitude of the algorithm error. Based on the AUG Expert's experience in the gas demand forecasting domain, we believe that the algorithm forecast will have an average daily error of at least 5% and maybe significantly more.

The GDNs generate daily aggregate forecasts of gas demand on an LDZ basis. The AUG Expert has taken actual demand and 13:00 day ahead forecast data from the National Grid website for EA LDZ as an example. Figure 2 below shows the forecast error from October 2016 to present.

Over this period, the average daily error is ≈4%. The error varies randomly from day to day and can be as high as 20%. The errors are generally more volatile in the "shoulder months" i.e. when the weather is changing from winter to summer and customers switch their heating on/off at different times. This pattern of errors is entirely consistent with what is being observed in UIG.

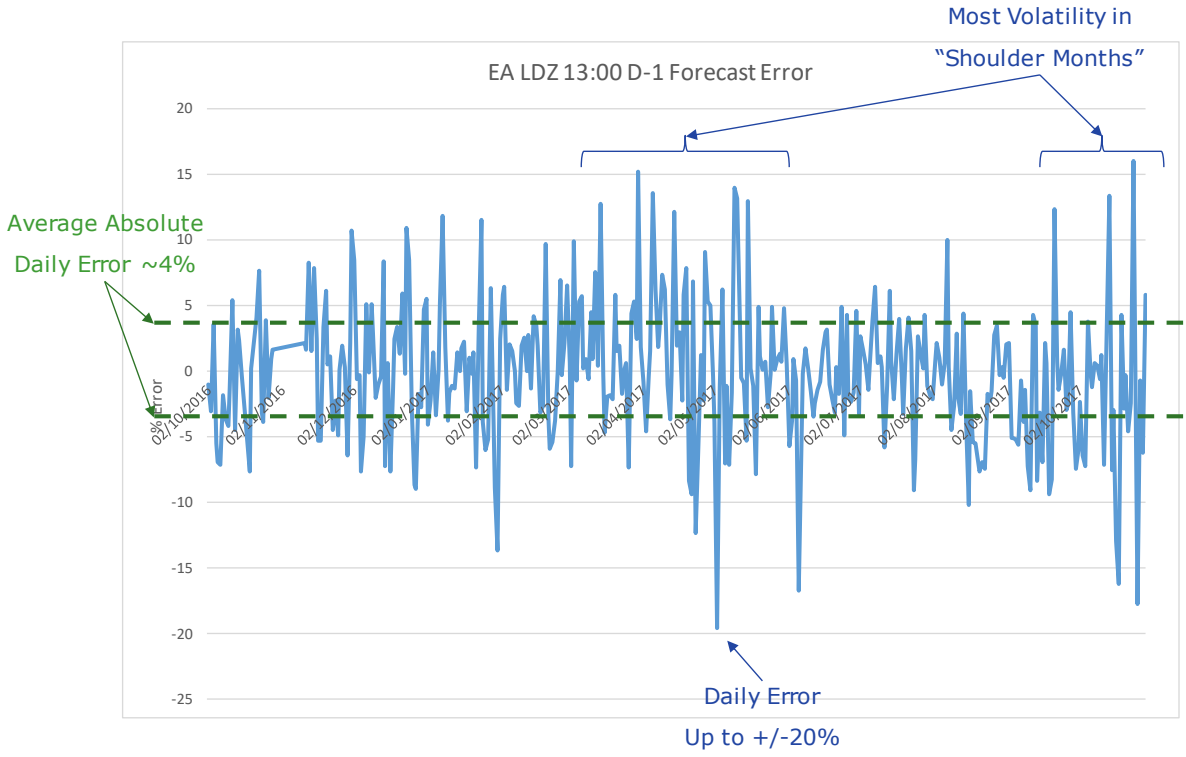

Figure 2: EA LDZ 13:00 D-1 Forecast Error over 1 year

The above analysis is based on LDZ level forecasting. These forecasts are generated using accurate LDZ level data and an ensemble of sophisticated models (regression, ARIMA, Neural Network etc.) which have been tuned over many years.

The allocation algorithm works using a broad-brush approach based on End User Categories: in effect, any load in the same EUC is assumed to follow the same pattern of consumption because ALPs, DAFs and WCFs are all defined on an EUC by EUC basis (with an additional split by WAR band in some cases). In reality, however, loads within any given EUC can vary widely in nature despite having similar AQs, and in particular, can show different levels of temperature dependency that is only partially reflected in the WAR bands.

For example, a school, shop, pub and dentist could all share the same AQ, and if they did, they would all be allocated the same value by the algorithm. In reality, they will all have different load profiles, resulting in them having different daily loads even under the same weather conditions. All will have different day-of-week profiles that the current form of the algorithm only partially picks up; all will have different temperature sensitivities, which dependent on EUC may not be picked up at all; and all will have different within-day load profiles, which will lead to them having different daily load totals.

The allocation algorithm is not capable of picking up any of these effects, and so they appear as noise (i.e. additional variation) around the model output and hence increase model error. In addition, any statistical model is subject to what is known as "common cause variation", which is the additional day-to-day fluctuations in demand that are random in nature and cannot be modelled. The overall error in the daily allocation algorithm figures is a combination of the noise due to known effects that it does not fully pick up through its calculation method, plus the genuinely random common cause variation. The combination of these two effects is the source of the highly variable UIG values that have been observed because the Mod 432 method bundles all model error in with the UIG figure.

Analysis carried out by DNV GL, based on simulated UIG error information provided by Xoserve to DESC, shows that errors from the new allocation formula are likely to lie in the range ±14% (95% Confidence Interval). Therefore, given that the current best estimate of Unidentified Gas is 1.1% of throughput, the "UIG plus model error" output produced by the Mod 432 formula is dominated by model error. The large variations observed in the day to day UIG values and their unpredictable nature are both consequences of this.

This problem is compounded by the removal of SF from the allocation algorithm. The actual (known) daily LDZ load is a valuable piece of data, which when used in the algorithm has the ability to remove a great deal of the error described above. In other words, SF was a major factor contributing to the accuracy of the old version of the algorithm. The removal of this factor was intended to leave the difference between the LDZ intake and the allocation as a "balancing factor" representing UIG, but for the reasons described above it does not do this. Removing SF in fact increases the error in the allocation process and adds to the observed variability in the daily Mod 432 UIG figure.

The Solution

It should be noted that the problem as described above cannot be solved by attempting to improve the accuracy of the allocation algorithm. The fundamental issue is that the Mod 432 calculation produces output that is UIG plus model error rather than just UIG, and that as things stand this combination is dominated by the model error. Given that Unidentified Gas is approximately 1% of throughput, in order for UIG to become the dominant factor in the combination, this would require model error to fall to an average level of below 0.5%. The DNV GL simulation returned a current MAPE of around 5.2% for the allocations, which as demonstrated above is typical for a forecasting model of this type. It is not a realistic

aspiration for this to drop to a MAPE of 0.5%, and it is certainly not possible to achieve this with the allocation algorithm.

An alternative approach is therefore needed that avoids combining UIG with model error and is capable of reporting UIG in isolation. The AUG Expert's recommended solution is therefore to abandon the Mod 432 UIG calculation and use a completely different method that does not involve allocations. This will have the additional benefit of allowing SF to be reintroduced to the allocation algorithm, increasing its accuracy – this will also have a knock-on beneficial effect on other processes such as energy balancing.

1. Calculate daily UIG as a fixed percentage of throughput, based on the most recent figure available. This is 1.1%, which comes from the 2017/18 AUG Statement.

2. Put SF back into the allocation algorithm. SF should scale the allocations to "LDZ total - metered load - shrinkage - UIG", with UIG calculated as per step #1.

3. Create a threshold point for the percentage of meter reads have been received, at which point UIG will be recalculated using Mod 432 principles and reconciliation carried out. This threshold will have to be very high (e.g. 98%) and be in terms of both number of meters and AQ. Only when both conditions are satisfied should UIG be recalculated. Reconciliation will therefore only occur a considerable time after Day D, but the initial UIG figure will be more accurate meaning this delay will not cause any issues – reconciliation will only involve minor changes to the final value.

It is recognised that this approach will require a change to the UNC because it fundamentally alters the way that UIG is calculated, as well as changing the allocation algorithm. This can be done via a Modification, and should be done as quickly as possible in order to allow the new calculation to be put into place at the earliest opportunity.