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frontier economics

9 MAY 2019

UAG METHODOLOGY – UPDATE TO COEFFICIENTS

A REPORT PREPARED FOR JEMENA GAS NETWORK

CONTENTS

Tables

Figures

EXECUTIVE SUMMARY

Jemena Gas Networks (JGN) is currently in the process of preparing its Access Arrangement (AA) proposal for the forthcoming AA period from 1 July 2020 to 30 June 2025 (the 2020–25 AA). As part of its proposal, JGN forecasts the cost of replenishing gas that is lost, or unaccounted for, during delivery through the distribution network (i.e., unaccounted for gas or UAG).

In the 2015–20 AA, JGN forecast UAG costs based on the product of:[1]

- The target rate (loss rate) of UAG (split into two markets: volume market and demand market)
- Total gas receipts
- The cost of replacement gas.

For the 2020–25 AA JGN is proposing to adopt the same approach to forecast the UAG rate accepted by the AER in the 2015–20 AA[2] and has engaged Frontier Economics to assess and update this approach with the latest data up to December 2018.

In our opinion, after accounting for some measurement errors and anomalies in the data, the 2015–20 approach for estimating constant rates of UAG for the two market segments remains valid for the purpose of the 2020–25 AA proposal. In order to minimise the impact of sample size on the estimated UAG rates, we recommend that as large a sample as possible be used in the estimation, which in this case is the sample of monthly observations from July 2002 to December 2018.

The updated total UAG rate is 2.866%. The updated estimates of the UAG coefficients are the following:

- for forecasting UAG costs:
  - 0.705% of forecast withdrawals for the demand market
  - 5.925% of forecast withdrawals for the volume market
- for annual true-ups:
  - 0.665% of withdrawals for the demand market
  - 5.593% of the balance of total market receipts for non-daily metered market (comprising volume market withdrawals and UAG).

[1] AER, *Draft decision for Jemena Gas Networks (NSW) Ltd Access Arrangement 2015-20, Attachment 7*, November 2014, pp. 7-26 to 7-28.

[2] AER, *Final decision for Jemena Gas Networks (NSW) Ltd Access arrangement 2015-20, Attachment 7*, June 2015, p. 7-32.

1 INTRODUCTION

Jemena Gas Networks (JGN) is currently in the process of preparing its Access Arrangement (AA) proposal for the forthcoming AA period from 1 July 2020 to 30 June 2025 (the 2020–25 AA). As part of its proposal JGN forecasts the cost of replenishing gas that is lost, or unaccounted for, during delivery through the distribution network (i.e., unaccounted for gas or UAG).

In the 2015–20 AA, JGN forecast UAG costs based on the product of:[3]

- The target rate (loss rate) of UAG (split into two markets: volume market and demand market)
- Total gas receipts
- The cost of replacement gas.

The approach used to estimate the UAG rates for the two markets was proposed by JGN in its 2015–20 AA proposal[4] and accepted by the AER in its final decision.[5] The approach was based on a revision of JGN's original procedure for estimating the UAG rates, following advice by Frontier Economics. Frontier Economics' assessment of JGN's original approach and the revised methodology was submitted to the AER in a report titled 'UAG coefficients statistical methodology' (henceforth, *Frontier's 2014 analysis*).

For the 2020–25 AA, JGN is proposing to adopt the same approach to forecast the UAG rate and has engaged Frontier Economics to assess and update the approach with the latest data up to December 2018.

1.1 Our terms of reference

To assist in assessing and updating the above approach, JGN has engaged Frontier Economics to advise on:

- updating Frontier's 2014 analysis on the strength of the statistical correlation between UAG and withdrawals for the two separate markets with the most recent data up to December 2018
- determining the corresponding UAG rates/coefficients for the two markets
- calculating those rates and statistical relationship for the purposes of inclusion in JGN's 2020–25 AA proposal.

This report presents our findings.

1.2 Structure of the remainder of this report

The remainder of this report is structured as follows:

- In Section 2 we present the data used for the analysis and we discuss possible approaches to treat measurement errors identified in the historical data
- In Section 3 we summarise the 2015–20 approach for estimating the UAG rates

[3] AER, *Draft decision for Jemena Gas Networks (NSW) Ltd Access Arrangement 2015-20, Attachment 7*, November 2014, pp. 7-26 to 7-28.

[4] Jemena, *2015-20 Access Arrangement Information, Appendix 7.5, UAG methodology and justification*, June 2014.

[5] AER, *Final decision for Jemena Gas Networks (NSW) Ltd Access arrangement 2015-20, Attachment 7*, June 2015, p. 7-32.

- In Section 4 we present the analysis updated with the latest data
- In Section 5 we summarise our findings.

2 DATA

2.1 Description of data series

JGN has provided us three data series which can be used to update Frontier's 2014 analysis for estimating the UAG rates. The data series have been provided on a monthly basis for the period from July 2002 to December 2018 and all data series are measured in TJ.

Below we list the data series provided to us with a brief description of each series.

- **Receipts (R).** Gas volumes received by JGN from suppliers.
- **Daily metered (i.e. demand market) withdrawals (I).** Gas volumes delivered to customers metered on a daily basis, which constitute the demand market. These are mainly large industrial customers, and hence we indicate this quantity by I.
- **Estimated unaccounted for gas (U^e).**[6] We have attached a superscript to this quantity because it is not based on direct measurement.

In the remainder of the report we also use the following data series, which have been derived from the data series provided by JGN:

- **Tariff market residual (T).** This series is calculated as the residual between receipts and daily metered withdrawals. This consists of the volumes delivered to the market segment of customers who are not metered on a daily basis (i.e. the volume market) plus U^e.[7]
- **Unaccounted for gas (U).** We reserve the term U, without a superscript, for the true (unobserved) volume of unaccounted for gas.
- **Non-daily metered (i.e. volume/mass market) withdrawals (M).** Gas volumes delivered to customers not metered on a daily basis, which constitute the volume market (also referred to as mass market).

The following relationships hold between these variables:

$$T = R - I = M + U.$$

U^e is a derived quantity obtained by using an estimate of M, say M^e, from billing data. By re-writing the equation above we obtain:

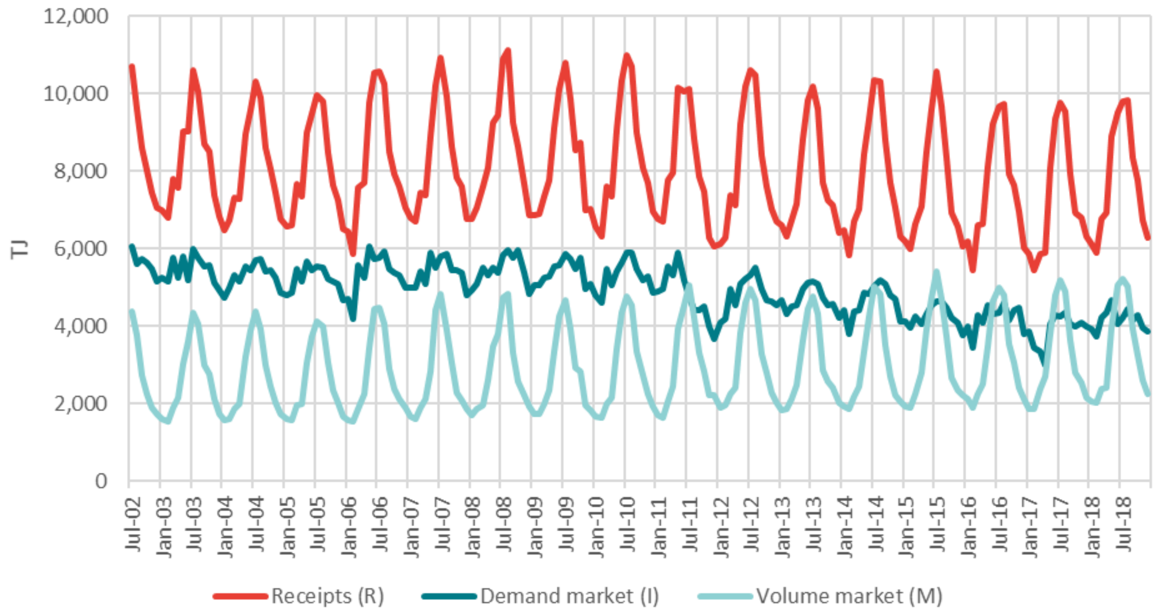
$$U^e = T - M^e = R - I - M^e.$$

Figure 1 to **Figure 3** below plot these series over time. The charts show that daily metered withdrawals have been decreasing since about 2011, while the tariff market residuals have increased over time. Note that as UAG is relatively constant over time, the increase in the tariff market residual is driven by an increase in non-daily metered withdrawals.

[6] We understand from JGN that, due to bill reversals, the historical UAG data from January 2011 to June 2013 has been slightly revised with respect to the data used in Frontier's 2014 analysis. The average change over this period is 0.1%, the maximum change is 1.5%, and the minimum change is -2.4%.

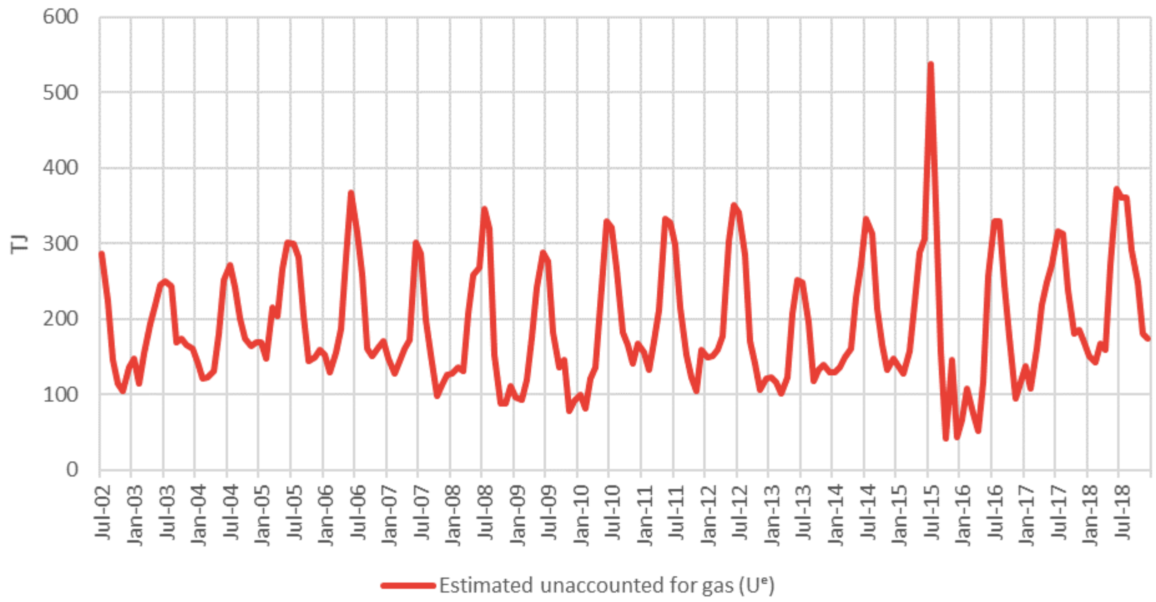
[7] The tariff market residual includes all of UAG, not only the UAG attributable to the volume market.

Figure 1: Receipts, demand market withdrawals, and volume market withdrawals by month



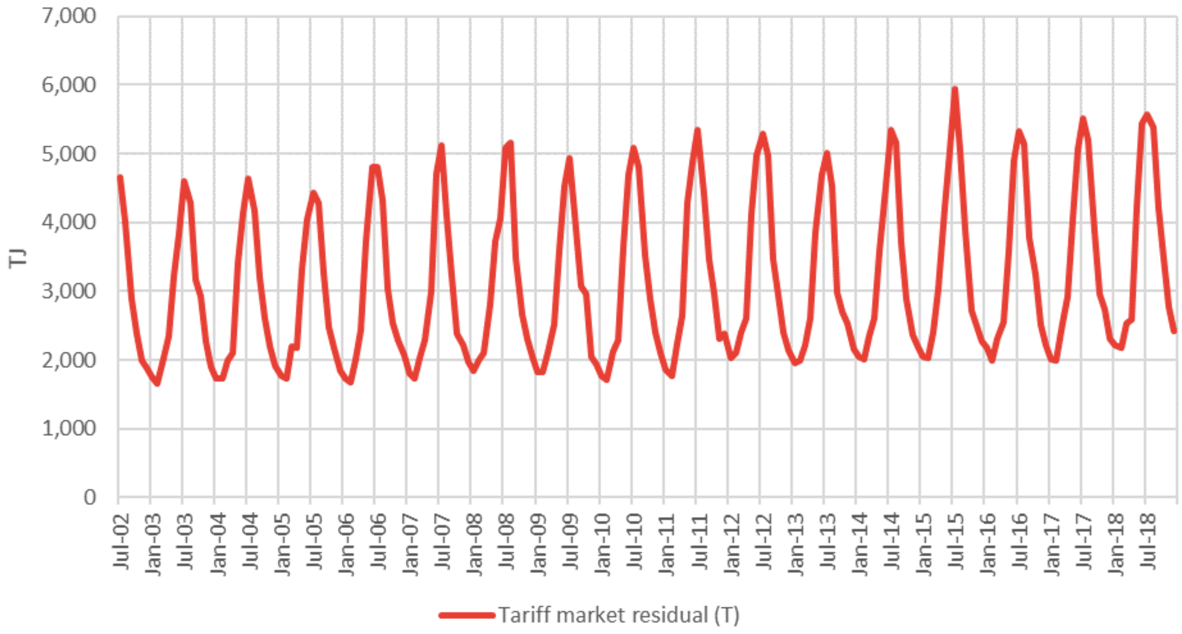
Source: JGN

Figure 2: Estimated unaccounted for gas by month



Source: JGN

Figure 3: Tariff market residuals by month



Source: JGN

2.2 Data issues

JGN identified the following two issues which affected the historical time series:

- In 2015 JGN transitioned its IT systems from GASS+ to SAP. This transition was accompanied by changes in the reporting of UAG from July 2015.
- In March 2017, APA Group installed a new orifice plate[8] at the receipts point for APA's Moomba to Sydney pipeline at Wilton (henceforth, *Wilton APA*). JGN informed us that the new orifice plate is more accurate at measuring lower flow ranges.

We assess the likely impact of these two issues on the data series in the following two subsections.

2.2.1 Transition of UAG reports from July 2015

As can be seen from **Figure 2** above, the transition of UAG reporting from July 2015 appears to have affected the UAG monthly volumes for several months after the transition date. In particular, we observe that:

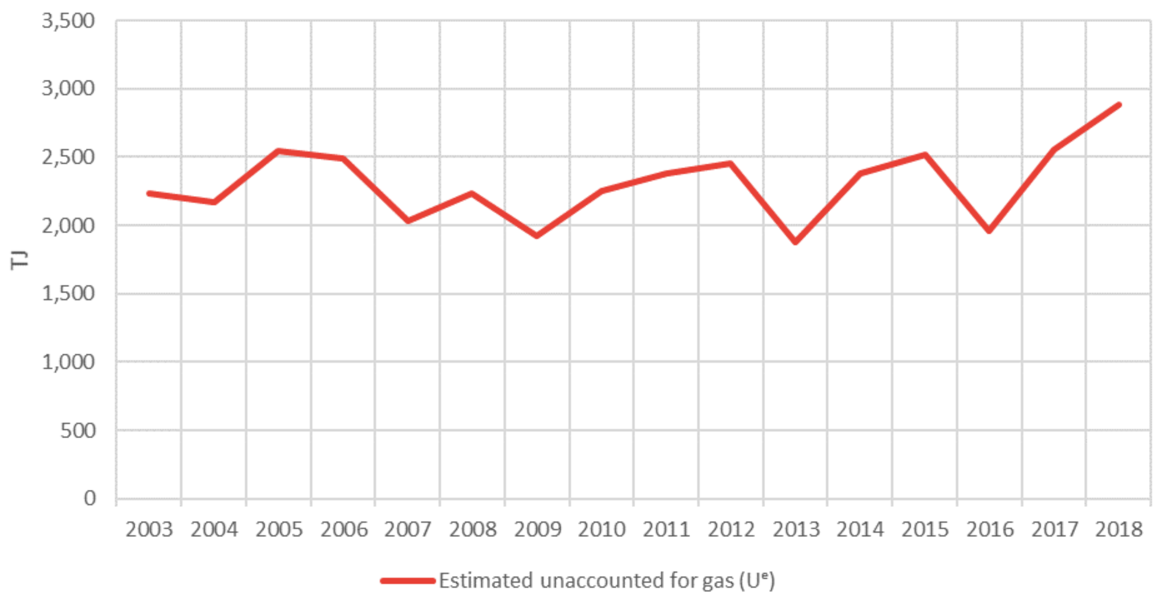
- the UAG volume in July 2015 (538 TJ) is the highest volume measured over the whole historical period, almost 1.5 times larger than the second highest volume since July 2002 (373 TJ recorded in June 2018).
- the five UAG volumes in October 2015, December 2015, April 2016, January 2016, and March 2016 are the five smallest volumes recorded over the whole historical period. In particular, the October and December volumes (42 TJ and 44 TJ, respectively) are more than 40% smaller than the sixth smallest volume since July 2002 (79 TJ recorded in November 2009).

[8] An orifice plate is a device used for measuring flow rates.

These observations are likely to influence results from models that use monthly data.

However, once the monthly data is aggregated by year, the annual UAG volumes for 2015 and 2016 do not particularly stand out, as can be seen from **Figure 4** below.

Figure 4: Estimated unaccounted for gas by calendar year



Source: JGN

The chart shows that annual volumes in 2015 and 2016 are not unusually large or small. Indeed:

- The 2015 UAG volume (2,521 TJ) is the fourth highest volume over the historical period, 12% lower than the highest volume.
- The 2016 UAG volume (1,963 TJ) is the third smallest volume over the historical period, 4% higher than the smallest volume.

2.2.2 Installation of more precise meter at Wilton APA in March 2017

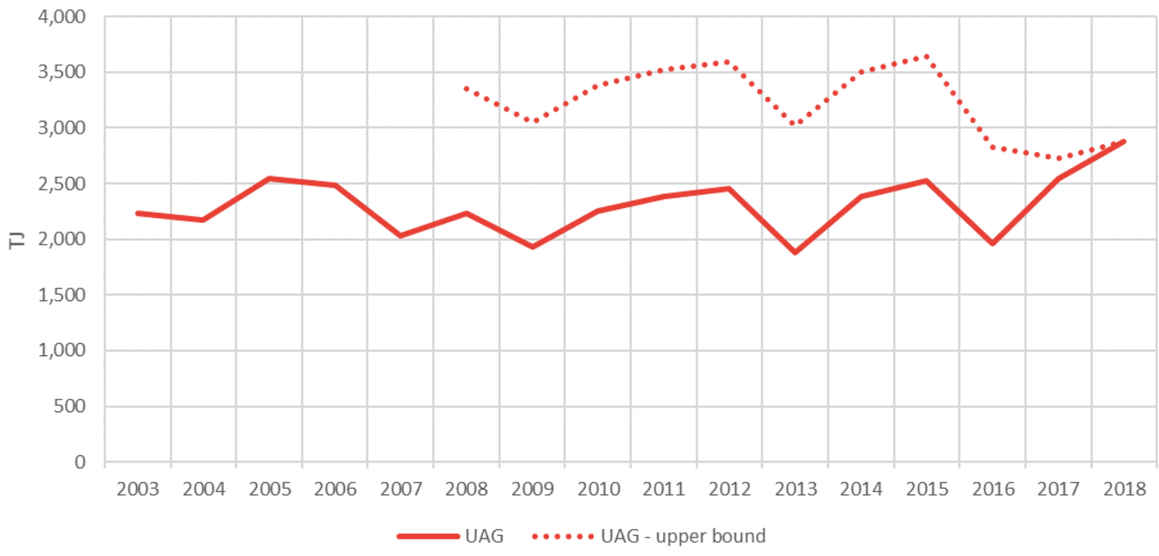
The new orifice plate installed at Wilton APA in March 2017 is more precise than the previous orifice plate at measuring flow rates in the low flow-rate range. Experience with the new orifice plate indicates that historical receipts, UAG, and tariff market residuals before March 2017 are likely to have been under-measured, especially in periods of low flows.

In order to assess the impact of this undermeasurement on the historical data series, JGN estimated the maximum undermeasurement at Wilton APA for each month from September 2007 to March 2017. The maximum undermeasurement can be used to estimate the maximum volumes of the historical series of UAG, receipts, and tariff market residuals if the more precise orifice plate had been used before March 2017. We note that the UAG volume, being the smallest volume amongst the three series, will be the most affected (in percentage terms) by the undermeasurement.

To show the impact of the undermeasurement, we have used the information that JGN provided to us to estimate an upper bound for the annual UAG volumes from 2007 to 2018. We have done this by first aggregating the estimated maximum undermeasurement by calendar year and then adding the aggregated undermeasurement to the original estimate of UAG. **Figure 5** below shows both the original estimates of annual UAG volumes (solid red line) and its upper bound (dotted red line). The chart shows that the UAG volumes could have been as much as 50% higher (on average over 2008–2016) if the more precise orifice plate had been used before March 2017.

The potential magnitude of the undermeasurement of UAG and its impact on the estimation of the UAG rates for the two market segments and the overall UAG rate is substantial. Hence, we have modified our modelling approach to enable us to obtain estimates of the actual undermeasurements, and to adjust the affected variables accordingly. Details are provided in Sections 4.1 and 4.2.

Figure 5: Comparison of UAG estimates by calendar year



Source: Frontier Economics calculations based on JGN's data.

Note: We were only able to calculate an upper bound for UAG from calendar year 2008 onwards, since JGN was able to provide estimates of the maximum undermeasurement only from September 2007 onwards.

2.3 Data used for analysis

The data issues identified in Section 2.2 can affect the estimates of both the UAG rates for the two market segments and the overall UAG rate. As such, we have made the following decisions to address these issues.

- UAG rates for the two market segments.
  - As the estimation of the UAG rates for the two market segments relies on monthly data, to remove the impact of the influential observations identified in the previous section we have omitted 13 observations from the estimation sample: 12 observations corresponding to the 12-month period which starts in July 2015,[9,10] when UAG reports transitioned from GASS reports to BO reports, and 1 observation corresponding to March 2017, when the more precise orifice plate was installed.

[9] Since gas withdrawals are very seasonal, we exclude all 12 months of data for FY2016 in order to maintain the monthly balance in the estimation sample.

[10] This decision is supported by sensitivity analysis on a model that includes FY2016 data. See Section 4.1.1.

- We have also modified the model's specification before March 2017, as the undermeasurement can bias the results if it is not properly accounted for. More details on the approach adopted can be found in Section 4.1.

- Overall UAG rate.
  - As the estimation of the overall UAG rate relies on annual data, which is not affected by the monthly influential observations (as shown in **Figure 4**), when we estimated the overall UAG rate we retained the 13 observations which we have instead removed from the monthly analysis.
  - Note, however, that the undermeasurement at Wilton APA has an impact on the estimation of the overall rate. Hence, we have made appropriate adjustments to the historical data to account for the undermeasurement. Details of the approach adopted can be found in Section 4.2.

3 SUMMARY OF 2014 ANALYSIS

In this section we summarise the methodology for estimating UAG rates accepted by the AER in the 2015–20 AA.

3.1 2015–20 AA methodology

In our 2014 report we proposed some improvements to JGN's original analysis for estimating constant UAG rates for the two markets. The updated methodology can be divided into three main steps:

- **Step 1 – Estimation of constant UAG rates α_I and α_T for the demand market I and tariff market residual T** as follows:
  - estimate the following model[11] using monthly data

    $$U_t^e = \beta_I I_t + \beta_M M_t^e + \eta_t \qquad (1)$$

  - express U_t^e as a function of I and T as follows

    $$U_t^e = \alpha_I I_t + \alpha_T T_t$$

    where the UAG rates can be calculated[12] as:

    $$\alpha_I = \frac{\beta_I}{1 + \beta_M}$$

    $$\alpha_T = \frac{\beta_M}{1 + \beta_M}.$$

- **Step 2 – Estimation of overall UAG rate.** Estimate the overall UAG rate over the last five years as the ratio of total UAG divided by total receipts over the last five years.

- **Step 3 – Calibration of rates.** In order to ensure that the total predicted UAG from the model estimated at Step 1 matches the total actual UAG over the last five years from Step 2, calibrate the estimated UAG rates α_I and α_T to obtain UAG rates α_I^* and α_T^* that guarantee this consistency by following these steps:
  - set $\alpha_I^* = \alpha_I$
  - predict unaccounted for gas for I for each of the last five years as $U_t^I = \alpha_I^* \cdot I_t$
  - predict unaccounted for gas for T for each of the last five years as $U_t^T = U_t - U_t^I$
  - estimate the UAG rate for T that guarantees that total predicted UAG matches total actual UAG in the last five years as $\alpha_T^* = \sum U_t^T / \sum T_t$. Corresponding rates β_I^* and β_M^* consistent with α_I^* and α_T^* can then be derived by reversing the relationship between these coefficients indicated at the end of Step 1 above.

[11] Note that this model overcomes the endogeneity problem identified in the original approach proposed by JGN. For a complete discussion see Frontier's 2014 analysis, pp. 6-7.

[12] See Frontier's 2014 analysis, p. 7.

4 UPDATING 2014 METHODOLOGY WITH DATA TO DECEMBER 2018

In this section we derive an updated set of estimates for the UAG rates by updating the 2014 methodology to take into account the undermeasurement that took place before March 2017 and to include the most recent data to December 2018. We also present the sensitivity analysis we have undertaken to check the validity of the results.

4.1 Step 1 – Estimation of UAG rates for the two market segments

Equation (1) in Section 3.1 shows the relationship between the estimated UAG, the daily withdrawals and the estimated non-daily withdrawals. As the estimated UAG was underestimated before March 2017 (see Section 2.2.2), the estimated coefficients from model (1) are likely to be biased downwards if the undermeasurement is not accounted for in the model.

In order to account for the undermeasurement at Wilton APA before March 2017, we have defined a variation of model (1) in which the coefficients β_I and β_M are allowed to be lower[13] before March 2017. This is achieved by interacting the coefficients with a dummy variable which is equal to 1 for each month before March 2017 and 0 otherwise. The coefficient on the dummy variable, γ, indicates the rate of undermeasurement before March 2017. Another way of looking at this model is that it assumes that the predicted values, $\widehat{U}_t^e$, for UAG before March 2017 are lower than the predicted values after March 2017, due to the undermeasurement, by a fraction equal to γ. In formula:

$$U_t^e = (\beta_I I_t + \beta_M M_t^e) \cdot \left(1 - \gamma \cdot d_{preMarch2017}\right) + \eta_t, \quad \gamma \geq 0. \tag{2}$$

Moreover, as the measurement error at Wilton APA varies according to the gas flow rate, i.e. a higher error at smaller flow rates, and the flow rate is seasonal, we have also defined a second variation of model (1) in which the rate of undermeasurement is allowed to differ by month of year. This is achieved by interacting the coefficients with two types of dummy variables: a period dummy variable which is equal to 1 for each month before March 2017 and 0 otherwise, and monthly dummy variables which are equal to 1 if the observation falls in a particular month and 0 otherwise. In formula:

$$U_t^e = (\beta_I I_t + \beta_M M_t^e) \cdot \left(1 - d_{preMarch2017} \cdot \sum_{i=1}^{12} \gamma_i \cdot m_i\right) + \eta_t, \gamma_i \geq 0. \tag{3}$$

We have estimated the models presented in equations (1), (2), and (3) using monthly data from July 2002 to December 2018, but excluding the influential observations in FY2016 and March 2017 for the reasons indicated in Section 2.3. The estimated coefficients with their significance levels are shown in

[13] When taking the interactions into account, the coefficients β_I and β_M are estimated to be lower before March 2017 than after March 2017, because, before March 2017, UAG is lower than what it would have been if there had been no undermeasurement.

Table 1 below. The table also reports three commonly used measures of goodness of fit of the model to the data, [14] which can be used to select the best fitting model.

Table 1: Estimated models

	(1)	(2)	(3)
β_I	0.00301**	0.00463***	0.00706**
β_M	0.06105***	0.06342***	0.06079***
γ		0.08079**	
γ_1			0.01301
γ_2			0.10485
γ_3			0.08317
γ_4			0.00042
γ_5			0.00000
γ_6			0.00000
γ_7			0.07139**
γ_8			0.14596***
γ_9			0.24205***
γ_{10}			0.27087***
γ_{11}			0.25430***
γ_{12}			0.06228
Adjusted R^2	0.973	0.974	0.983
AIC	1831.0	1827.3	1770.5
BIC	1837.4	1837.0	1815.6

Source: Frontier Economics.

*Notes: 1. p-values are as follows: *** p<0.01, ** p<0.05, * p<0.1.*

2.The coefficients of the dummy variables have been constrained to be non-negative since they capture the rate of undermeasurement.

[14] The three goodness of fit statistical criteria reported in the table are: adjusted R^2, AIC, BIC. Adjusted R^2 is the adjusted coefficient of determination, the higher the coefficient the better the fit. AIC and BIC are the Akaike information criterion and the Bayesian information criterion, respectively. The smaller these information criteria the better the fit.

The table shows that all models provide plausible results, as the coefficients of the demand market and volume market have the expected sign and magnitude, and are statistically significant. The large values for the adjusted R^2 show that all models fit the data well. Note that there are differences in the estimated coefficients for the demand market, which varies from 0.00301 to 0.00706; however, these UAG rates are all very small, which reflects the fact that the demand market makes only a minor contribution to UAG.[15]

The table shows that both models (2) and (3), which estimate the undermeasurement before March 2017, fit the data better than the original model (1). This can be seen by comparing the three different measures of goodness of fit reported in the last rows of the table. In particular, the fit of model (3) is far superior to the fit of both models (1) and (2).

For this reason, model specification (3) is our preferred model for estimating the UAG rates for the demand market and the volume market for the 2020–25 AA. Hence, our preferred estimate for the UAG rate for the demand market is $\beta_I = 0.706\%$ and for the volume market is $\beta_M = 6.079\%$. These are the estimates before calibration, which is undertaken in Step 3 (see Section 4.3).

4.1.1 Sensitivity analysis

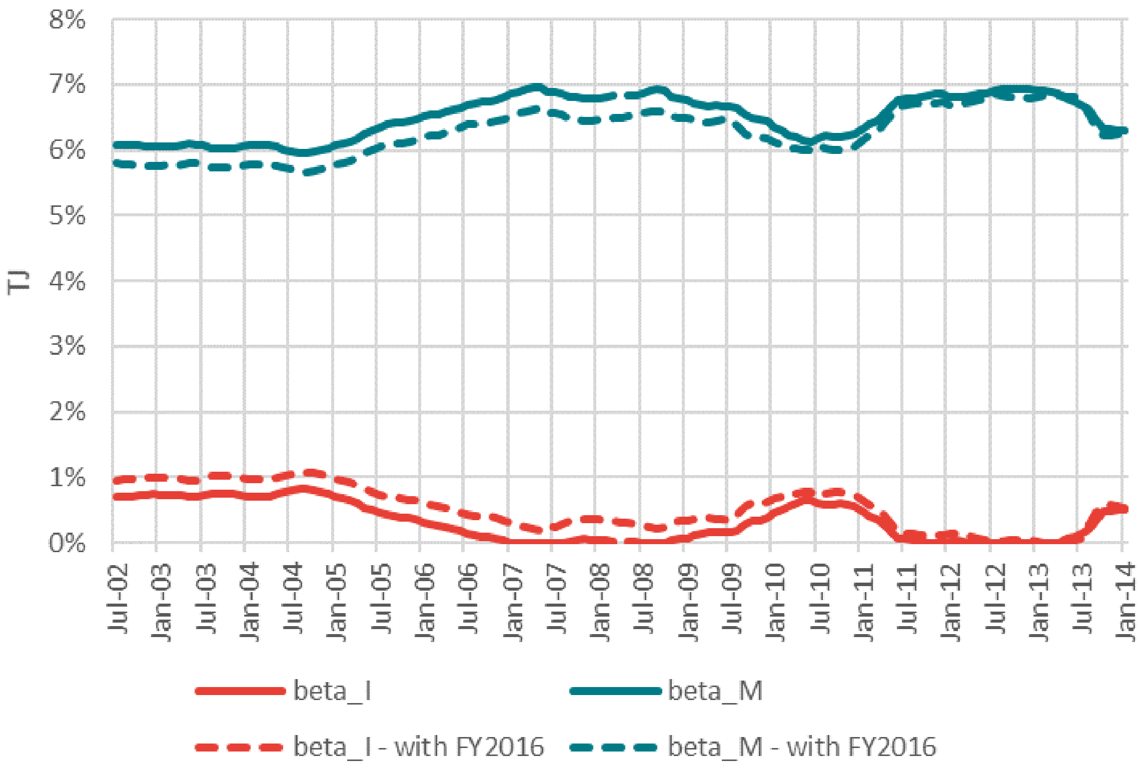
To test the stability of the results and the impact of excluding the influential observations from FY2016, we have estimated our preferred monthly regression model (3) using shorter time periods, as well as both including and excluding FY2016 data.[16] We have defined 139 different time periods, which start at each month from July 2002 to January 2014 and end in December 2018. Hence, we have estimated a total of 139 regressions for the models that include FY2016 data, and other 139 regressions for the models that exclude FY2016 data. The resulting estimated coefficients β_I and β_M for each estimation period are shown in Figure 8 below. The chart contains four f lines:

- The two solid lines represent the estimated coefficients for the datasets that exclude FY2016 observations, with the red line representing the estimates for the demand market and the blue line representing the estimates for the volume market. The coefficients are plotted against the starting point of the estimation period used to derive them. For instance, the coefficients plotted against July 2002 are the coefficients estimated using all data between July 2002 and December 2018 (excluding FY2016 and March 2017), while the coefficients plotted against July 2010 are the coefficients estimated using all data between July 2010 and December 2018 (excluding FY2016 and March 2017).
- The two dashed lines represent the estimated coefficients for the models that include FY2016 observations (but exclude March 2017). Therefore, the difference between the solid lines and the dashed lines are due to the influence of the FY2016 observations.

[15] We understand from JGN that the majority of the daily metered customers are served by JGN's high pressure network, which is not affected by the same level of leakage and metering uncertainty as the non-daily metered customers. As such, the UAG rate of the daily metered customers is expected to be lower than the UAG rate of the non-daily metered customers. This is consistent with the estimated coefficients across the three models.

[16] March 2017 is excluded from all models estimated.

Figure 6: Estimated UAG rates over shorter time period and with/without FY2016 data



Source: Frontier Economics

Notes: 1. In the estimation, we have constrained the coefficients to be greater or equal than zero.

2. Coefficients are not reported for the model estimated from April 2008 excluding FY2016 data as the model did not converge with up to 1000 iterations. This does not affect the general conclusions that can be drawn from the chart.

By comparing the dashed and solid lines one can see that when FY2016 is included in the estimation period the estimated coefficients are more sensitive to the choice of the starting point, as the range of estimated coefficients is larger. For example, the range of β_M coefficients is 1.2% for the model with the influential FY2016 observations compared to 1% for the model without the influential observations. These results support our rationale for excluding FY2016 from the estimation, as explained in Section 2.2.

By considering the variability of the solid lines over time, one can see that the estimated rates are fairly sensitive to the period chosen and sometimes are equal to zero. For example, the estimated β_M varies between 5.960% and 6.962% and the estimated β_I varies between 0.000% and 0.815%. This is not an ideal situation. However, it appears that there is no clear trend in the estimated coefficients as we change the starting point of the estimation dataset. For instance, the estimate of the rate for the demand market increases when we use data in the regression starting in July 2002 up to when the starting point is July 2007; the estimate of the coefficient then decreases to the earlier values for starting points of the estimation dataset between July 2007 and July 2010; it then slightly increases up to January 2013 and then decreases again afterwards. The opposite pattern can be observed for the estimate of the rate for the demand market.

As we are attempting to estimate constant UAG rates over time we recommend that as long a period as possible be used to minimise the impact of this sensitivity.

4.1.2 Estimate of undermeasurement

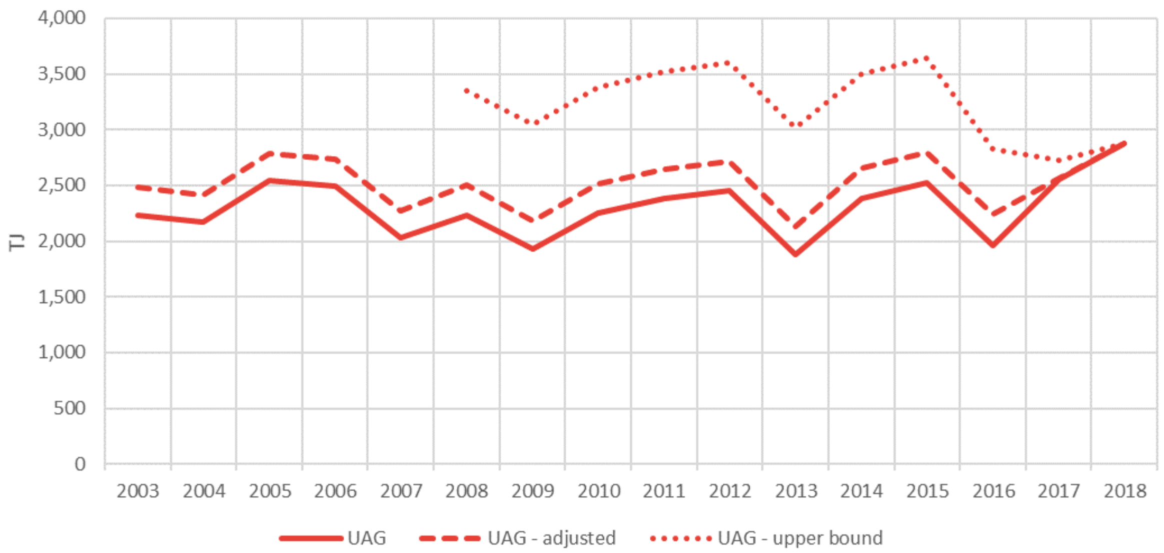
We note that the results from model (3) can be used to calculate an estimate of the historical undermeasurement at Wilton APA. Indeed, model (3) can be re-written as:

$$U_t^e = (\beta_I I_t + \beta_M M_t^e) - \Gamma_t$$

where Γ_t is the estimated undermeasurement at Wilton APA, which is zero on or after March 2017.[17] We have substituted the estimated coefficients from model (3) in **Table 1** into equation (3) and then estimated the undermeasurement Γ. The undermeasurement varies by month and depends on the actual volumes of the two market segments. On average over 2003-2017, the annual undermeasurement is 258 TJ.

The estimated undermeasurement can be used to adjust the historical data series of UAG, receipts, and tariff market residuals. For example, **Figure 7** compares the original annual estimate of UAG volumes (solid red line), with the UAG upper bound volumes provided by JGN (dotted red line) and the adjusted UAG volumes derived from model (3) (dashed red line). The chart shows that the UAG volumes adjusted for the undermeasurement are 12% higher (on average over 2008–2016) than the reported UAG volumes. The chart also shows that our adjusted UAG volumes are well within the UAG upper bound volumes provided by JGN.

Figure 7: Estimated undermeasurement at Wilton APA



Source: JGN, Frontier Economics

4.2 Step 2 – Estimation of overall UAG rate

As described in Section 4.2, the overall UAG rate is derived as the ratio of total UAG divided by total receipts over the last five years. In order to avoid underestimating this ratio, both the historical UAG and the receipts are adjusted by the undermeasurement estimated from our preferred model (3) (see Section

[17] We note that we have made a conservative assumption by assuming that there is no undermeasurement in March 2017.

4.1.2). In order to use the most recent data and to be consistent with our monthly models, we have estimated the overall UAG rate over the period 2014–2018.[18] In formula:

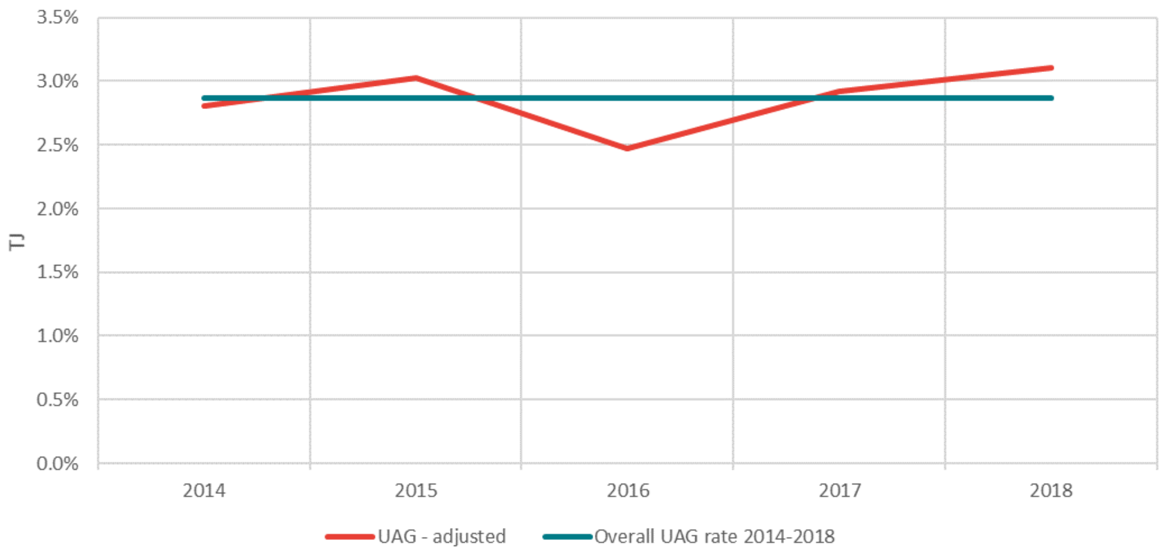
$$\hat{\alpha}_R = \sum_{t=2014}^{2018} (U_t^e + \Gamma_t) \Big/ \sum_{t=2014}^{2018} (R_t + \Gamma_t).$$

The estimate of the overall UAG rate in the past five years is 2.866%. This estimate is assumed to remain constant in the next AA period.[19]

4.2.1 Sensitivity analysis

Figure 8 below plots the annual UAG rate (derived as the ratio of UAG and receipts in each year) as well as the overall UAG rate estimated above. Both rates are derived using data adjusted for the undermeasurement estimated from our preferred model (3). The chart shows that in the past five years the UAG rate fluctuated between 2.475% and 3.103% over time, which could be partly driven by differences in weather between years. The UAG rate seems to show a very weak positive trend over time, which could be driven by multiple factors. One possible explanation could be that our model underestimates the adjustment required for correcting for the historical undermeasurement at Wilton APA. If the UAG rates before 2017 were adjusted upwards further, then this slight positive trend could disappear. As we are assuming a constant overall UAG rate (rather than a trending rate) our estimate is a conservative estimate of the overall UAG rate for the forthcoming AA period.

Figure 8: Annual UAG rate and overall UAG rate over 2014–2018



Source: Frontier Economics' analysis

[18] We have used the most recent five years of data, rather than data for the last five financial years as in our 2014 analysis, as more data was available for this analysis compared to the data available in 2014. Moreover, this approach has the following advantages: 1) the estimated overall UAG rate is more reflective of the most recent configuration and state of the network; 2) the estimation error due to the undermeasurement is reduced by including in the calculations more months where the undermeasurement is zero; 3) the sample used to estimate the overall UAG rate is consistent with the sample used to estimate the UAG rates for the two market segments, as both samples end in December 2018.

[19] We note that the estimated overall UAG rate can equally be applied to calendar year and financial year information, as this rate is assumed to be constant in the forthcoming AA period.

4.3 Step 3 – Calibration of rates

We have applied the approach described at Step 3 in Section 3.1 to calibrate the coefficients estimated using model (3) so that the overall UAG rate is equal to the rate of 2.866% derived in Section 4.2. The calibrated coefficients are:

- for forecasting UAG costs:
  - 0.705% of forecast withdrawals for the demand market
  - 5.925 % of forecast withdrawals for the volume market
- for annual true-ups:
  - 0.665% of withdrawals for the demand market
  - 5.593% of the balance of total market receipts for the non-daily metered market (comprising volume market withdrawals and UAG).

5 CONCLUSIONS

In this report we have updated our 2014 analysis to include the latest data available. In our opinion, after accounting for some measurement errors and anomalies in the data, namely the undermeasurement of historical UAG and receipts before March 2017 and influential observations in FY2016, the 2015–20 approach for estimating constant rates of UAG for the two market segments remains valid for the purpose of the 2020–25 AA proposal.

We recommend that, in order to minimise the impact of sample size on the estimated UAG rates, as large a sample as possible be used in the estimation, which in this case is the sample of monthly observations from July 2002 to December 2018.

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