UIG Task Force Investigation Findings

13.3.2: Accuracy of NDM Algorithm - NDM Sample Data – NDM Sample Population

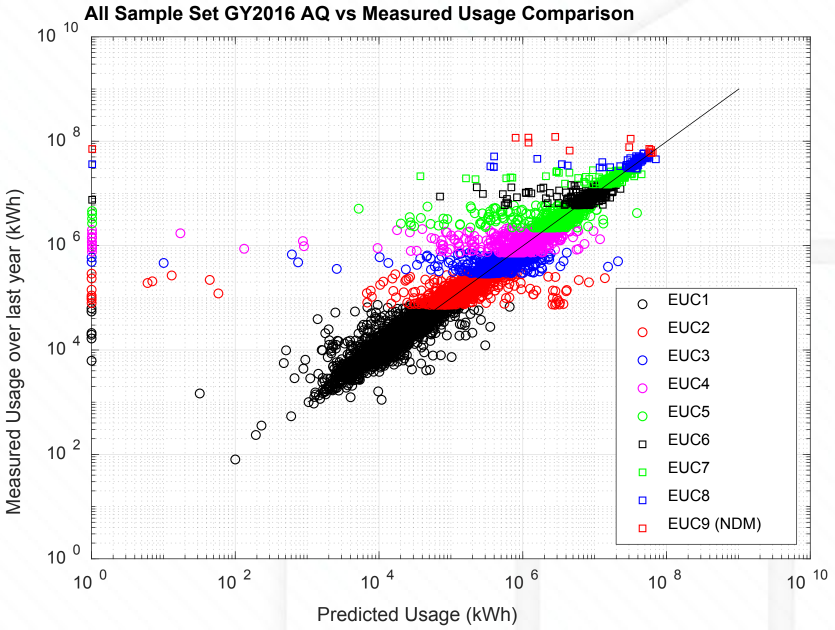
Summary of Findings

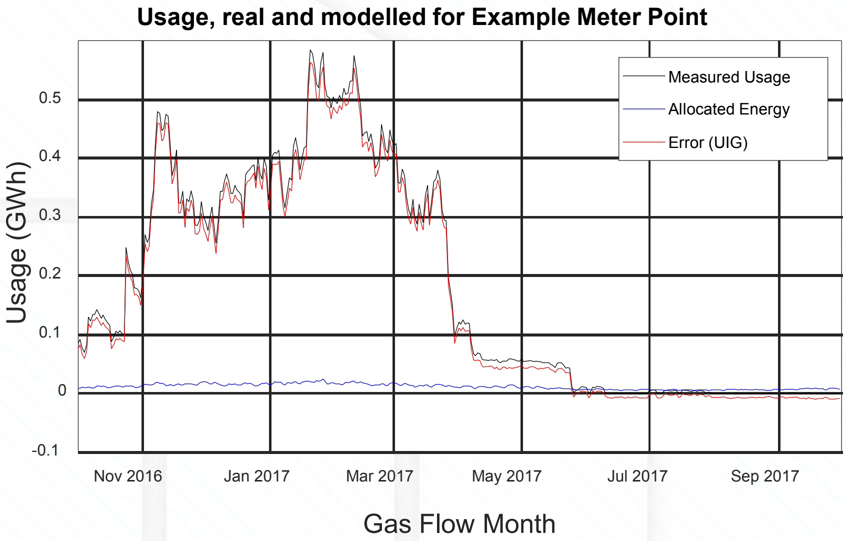
Findings Status	[Closed]
UIG Impact Peak Volatility %	N/A
UIG Impact Annual Average %	N/A
Confidence in Percentages	N/A

Area & Ref #	Accuracy of NDM Algorithm - NDM Sample Data - NDM sample population (Ref #13.3.2)
UIG Hypothesis	Do outliers within the NDM Sample have a significant impact on UIG (base and volatility)? With the NDM Sample set: how well does the NDM model predict demand, and does this contribute to volatility?
Data Tree References	ALP, DAF

Findings	Approach to analysis
Within the sample data set there are several large outliers where the UK Link AQs do not match the measured usage in the sample data. These have significant impact upon UIG – both in baseline and volatility. On the sample dataset the EUC9 outliers (sites whose AQ puts them in a different EUC band) contribute 2GWh baseline UIG and 0.8GWh UIG volatility (compared to 60GWh average baseline UIG and 64GWh UIG volatility) Extrapolating the impact of outliers from the sample set to the whole population of gas users is difficult and so the UIG Impact percentages are N/A. Subsets of this issue are investigated and quantified under investigation items 3.2.1, 3.2.2 and 3.2.8. The sample set contains many instances of sites where the UK Link AQ is significantly different to their observed usage. These can be seen to have a significant impact upon UIG, primarily upon baseline rather than upon volatility. The analysis has revealed a large set (~1%) of the sample set with these difference, which have been passed on for root-cause analysis – some root causes have been identified (Prime Meters, slow reporting of usage change)	The scatterplot of UK Link AQ vs observed usage is plotted for one gas year of the sample set. Individuals where these numbers are significantly different have been identified for root-cause investigation.

Supporting Evidence (1/1) – Identification and UIG effects of Outliers





The scatterplot (above left) shows the NDM Demand Model Sample users UK Link AQ for GY 2016-17 as compared to their observed total usage over the year.

- 50% of users had their AQ estimated usage within +-10% of their observed usage
- 240 users with an observed usage over 5 times greater than their AQ estimated usage have been identified
- 60 users with an observed usage less than 1/5 of their AQ estimated usage have been identified

The graph above right shows an example of one of the EUC9 outliers (it is in EUC6 on UK Link based on it's AQ) –as the allocated energy is significantly different to the measured energy there would be a large impact on UIG, although the impact for this site is pre-Nexus. This single user has a peak contribution of 0.5GWh to UIG – about 1% of the total national simulated UIG for the period. The impact of sites like these is explored further in the Pack *3.2.1 Inaccurate or Out of date AQs - Non-Daily Metered EUC09 Sites*.

Estimation of UIG by EUC using sample data

Summary of Findings

Findings Status	**[Closed]**
UIG Impact Peak Volatility %	**N/A**
UIG Impact Annual Average %	**N/A**
Confidence in Percentages	**N/A**

Area & Ref #	Accuracy of NDM Algorithm - NDM Sample Data - NDM sample population (Ref #13.3.2)
UIG Hypothesis	Previous analysis (NDM Sample Outliers) identified the contribution to 'sample set UIG' for each EUC. This result is limited to the sample set, but it may be extrapolated to the full meter population to determine the likely impact on volatility and base UIG for each EUC/LDZ. This allows us to quantify which groups of meter points (i.e. by EUC) might be contributing to UIG base and volatility.
Data Tree References	ALP, DAF, AQ, EUC

Findings	**Approach to analysis**
• UIG is dominated by EUC 1 & 2 (greater number of users in these EUCs) and EUCs 8 & 9 (due to very large individual site usage) • Baseline UIG is dominated by EUC1, and outliers (incorrect AQ) from EUC9 & EUC2 • Volatility of UIG is dominated by EUC1, with minor contributions from outliers from EUC9 • Domestic users contribute much more to volatility and baseline UIG than commercial users • The sample set UIG for EUC1 has significant day-of-week variability, especially (but not entirely) for Commercial users, as these are not currently modelled separately (there are Prepayment and Commercial EUC1 models ready to implement in October '19). • This variability does not appear in higher EUCs, nor in some LDZs (especially for Domestic users) suggesting there is a material difference in the makeup of site types in different LDZs which may not be represented in the NDM sample. • Significant volatility may be due to the NDM modelling in EUC1. The market appears to behave differently to the sample data in some LDZs, but not in others. Determining what causes this difference and mitigating it should reduce UIG. This line of investigation continues in the pack *13.3.1: Accuracy of NDM Algorithm - NDM Sample Data - Representation across EUCs.* The finding suggest that focusing efforts on reducing volatility using Machine Learning on the EUC1 population would potentially deliver the largest benefit to the industry.	For each EUC the proportion of gas usage in this EUC present in the sample set has been estimated. The baseline and volatility of UIG due to the sample set in each EUC is extrapolated to the size of the full meter population – this is split to highlight the different effects of correct AQs and incorrect AQs.

Supporting Evidence (1/5) – Extrapolated UIG

This table shows the extrapolated UIG from the sample set to the whole full meter population.

- **Baseline UIG metric is average UIG over year**
- **UIG Volatility metric is standard deviation of UIG over year:**

The extrapolation suggests that EUC1 domestic properties contribute significantly to baseline UIG

The extrapolation also suggests that EUC1 domestic properties contribute significantly to UIG volatility

EUC9 is also a significant contributor to baseline UIG and UIG volatility, although analysis has indicated that this is dominated by those meter points with ‘wrong’ AQs (where the stated AQ does not match the observed usage)

Note that it isn’t expected for the observed (actual UIG) to be the same as the estimated UIG: however it is the correct order of magnitude, especially for volatility.

EUC (based on sample data calculated consumption)	Estimated (extrapolated from sample data to full population) UIG (GWh)	
	Baseline	Volatility
EUC1 (Domestic)	18.8	60.9
EUC1 (Industrial/Commercial)	0.5	7.0
EUC2	-6.0	7.7
EUC3	-2.3	2.8
EUC4	0.0	2.8
EUC5	0.9	1.5
EUC6	1.3	1.0
EUC7	1.5	1.0
EUC8	2.5	2.3
EUC9	5.9	4.3
All EUCs	**28.5**	**62.1**

	Observed UIG (GWh)	
	Baseline	Volatility
All EUCs	**60**	**64**

Yellow indicates **significant** contributors either to UIG base or volatility

Supporting Evidence (2/5) – Extrapolated UIG

This table shows the extrapolated UIG from the sample set to the whole full meter population.

- Rows show results for each EUC
- We have compared the UK Link AQ with a Pseudo AQ (pAQ) derived from the measured consumption for each site in the NDM Sample.
- Primary column split distinguishes users where the AQ and pAQ have assigned them to the same EUC in both UK Link and the NDM Sample, from users where the AQ and pAQ have assigned them to different EUCs in UK Link and the NDM Sample.

- Baseline UIG metric is the average UIG over year:
  - Observed UIG had 60 GWh baseline
- UIG Volatility metric is standard deviation of UIG over year
  - Observed UIG has 64 GWh volatility

- Effects are dominated by EUC 1 & 2 (due to larger user populations) and EUCs 8 & 9 (due to very large individual usage)

- Baseline UIG: is dominated by the EUC1 (Match and mismatch EUC), EUC9 (mismatch EUC) and EUC2 (mismatch EUC)

- Volatility of UIG is dominated by EUC1, matching EUC, with minor contributions from EUC2, matching EUC, and EUC9, mismatching EUC.

- Extrapolation in EUC1 is somewhat speculative due to the relatively small sample size. However extrapolation in the higher EUCs is not very robust due to the very small sample counts. The relative significance of the EUCs, however, is unlikely to be affected significantly by this

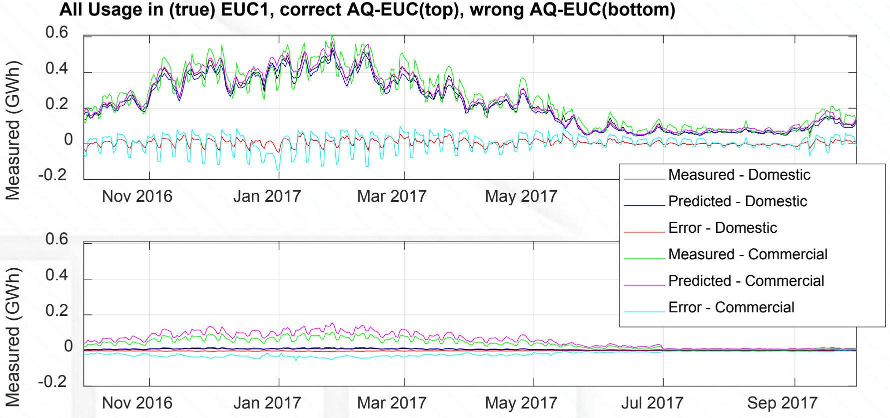
EUC (based on sample data calculated consumption)	Extrapolated UIG for users assigned same EUC on UK link and NDM Sample (GWh)		Extrapolated UIG for users assigned different EUCs on UK link and NDM Sample (GWh)	
	Baseline	Volatility	Baseline	Volatility
EUC1 (D)	22.7	60.9	-3.9	2.5
EUC1 (I)	1.1	7.0	-0.6	0.2
EUC2	-0.3	7.7	-5.7	2.1
EUC3	-0.5	2.8	-1.8	0.2
EUC4	-0.3	2.8	0.3	0.6
EUC5	-0.2	1.5	1.1	0.6
EUC6	0.0	1.0	1.3	0.6
EUC7	0.1	1.0	1.4	0.8
EUC8	0.6	0.5	1.9	2.3
EUC9	0.0	0.2	5.9	4.3

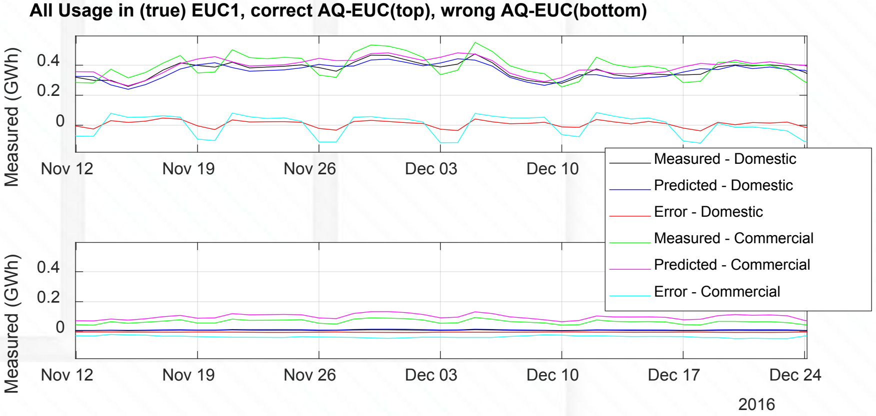
Supporting Evidence (3/5) – EUC1 Sample Set UIG with Domestic/Commercial Split

These graphs show the sample data UIG across all LDZs for EUC 1 with different lines for users labelled as domestic and for users labelled as commercial.

- **It is clear that there is a weak day-of-week effect in the domestic users, but a very strong such effect (and holiday season effect) in the commercial users**
- **As the model was built only on domestic users, it is not surprising that the performance is worse for commercial users**
  - **It is clear that the actual measured use of commercial users varies much more than the model allows.**

- **By volume, the sample set is roughly 60% Commercial and 40% Domestic. This implies that extrapolating from the sample set to the whole meter population (which has a much smaller proportion of Commercial use) will overestimate volatility somewhat.**





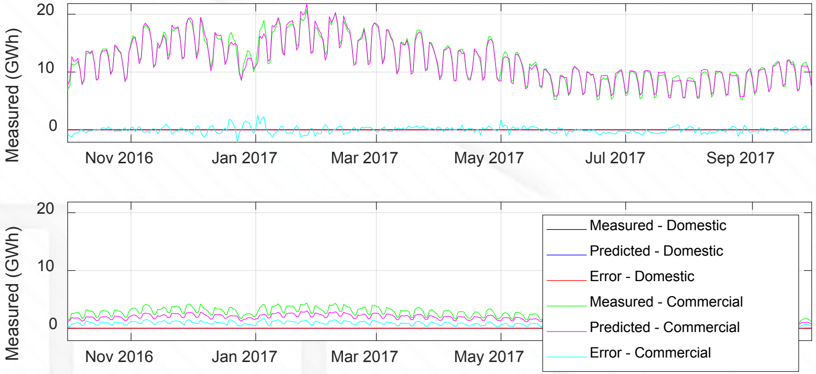
Supporting Evidence (4/5) – Examples without day-of-week effect

The top plots show that in EUC6 (similar results in EUC 4, 5 & 7) no residual day-of-week effect can be seen. Instead the graphs suggest (potentially) a lack of responsivity to weather / weather change as the errors all occur where the measured usage changes rapidly (day-to-day) and the prediction changes too slowly

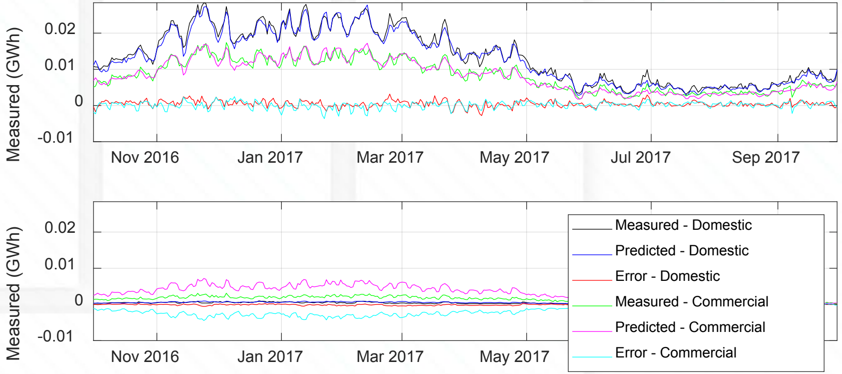
The bottom plots show Scotland for EUC1, where the day-of-week effect is not present. EA,NE are similar with SO not showing a day-of-week effect for the Domestic users.

- **This suggests there is something different about how the models are formed for these LDZs. These 4 LDZs have sample volatility (as a % of total energy usage) between 7% and 11%. The remaining 9 LDZs vary from 12% to 17%.**
- **One possibility is the addition of new users into the sample set**

All Usage in (true) EUC6, correct AQ-EUC(top), wrong AQ-EUC(bottom)



SC Usage in (true) EUC1, correct AQ-EUC(top), wrong AQ-EUC(bottom)



Supporting Evidence (5/5) – Extrapolated EUC1 UIG by LDZ

This table shows the extrapolated UIG from the sample set to the whole full meter population, limited to EUC1

- **Rows show results for each LDZ**
- **Primary column split distinguishes domestic users from industrial / commercial users**

- **Baseline UIG metric is average UIG over year:**
  - **Observed UIG had 60 GWh baseline**
- **UIG Volatility metric is standard deviation of UIG over year**
  - **Observed UIG has 64 GWh volatility**

- **Both effects are dominated the domestic users**

- **Baseline UIG: is dominated by domestic users**

- **Volatility of UIG is significantly lower (as a proportion of the LDZ usage) in the regions highlighted in cyan in EA, NE, SC and SO. (Also low in WN but this LDZ has much lower total usage than others)**

LDZ	Extrapolated UIG for Domestic Users (GWh)		Extrapolated UIG for Industrial / Commercial users (GWh)	
	Baseline	Volatility	Baseline	Volatility
EA	1.8	3.0	-0.4	0.5
EM	2.0	4.9	-0.0	0.0
NE	1.8	2.9	-0.0	0.0
NO	1.7	4.3	-0.0	0.1
NT	1.8	5.7	-0.0	0.0
NW	1.9	7.8	-0.2	0.0
SC	2.5	1.4	-0.0	0.0
SE	2.6	6.3	-0.2	0.5
SO	0.6	2.5	-0.3	0.4
SW	4.1	3.5	-0.1	0.1
WM	2.9	6.7	-0.1	0.3
WN	0.3	1.0	-0.0	0.0
WS	0.1	3.3	-1.2	0.8