13.3.1: Accuracy of NDM Algorithm - NDM Sample Data - Representation across EUCs

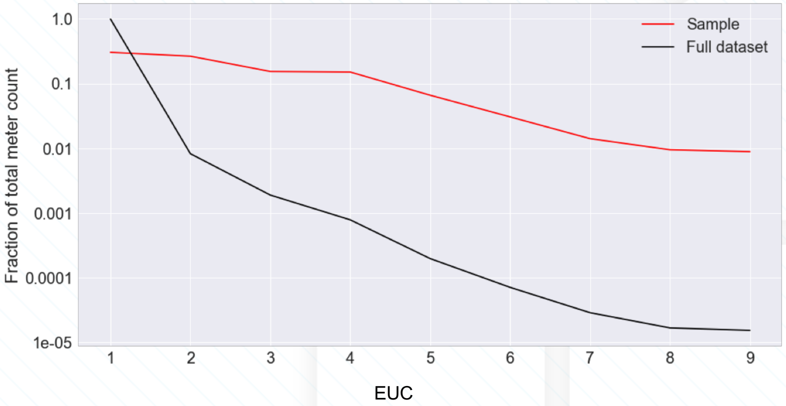
Summary of Findings

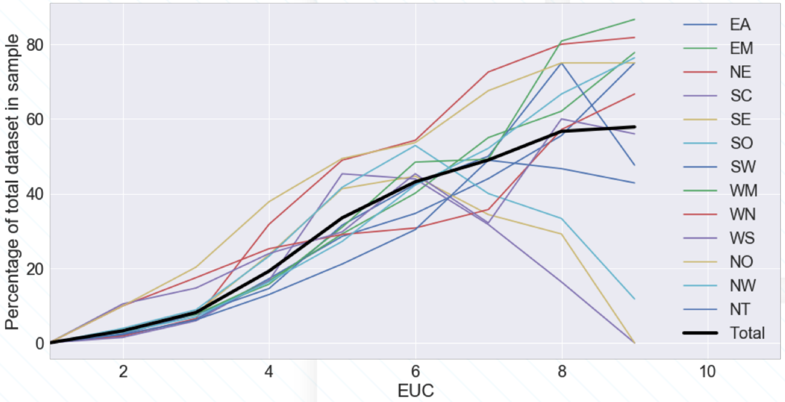
Findings Status	**[Closed]**
UIG Impact Peak Volatility %	**N/A**
UIG Impact Annual Average %	**N/A**
Confidence in Percentages	**N/A**

Area & Ref #	Accuracy of NDM Algorithm - NDM Sample Data - Representation across EUCs (Ref# 13.3.1)
UIG Hypothesis	There is a concern that the NDM sample set is *not* representative of the full population, which could result in inaccurate NDM Allocation if sites in the sample do not behave in the same way as sites in the whole market. - Representation by EUC: are there sufficient meter points in the sample set to represent the full population? - Understanding how the sample data maps to the full market data would allow extrapolation of figures calculated at the sample set data (where we have the full 'truth') up to the full market. If the differences between the NDM sample and the full population are significant, the NDM Algorithm may not correctly allocate energy resulting in UIG.
Data Tree References	ALP, DAF, AQ, EUC

Findings	Approach to analysis
Higher EUCs were found to be better represented in the sample. This was expected, as there are fewer meters in higher EUCs, so a greater fraction of the total is required for modelling, and is not a problem in itself. However the extremely low fraction of ~0.01% (and absolute number of hundreds) of samples in EUC1 indicates that this part of the sample may not be representative of the full data set. This is supported by the distributions of AQs in the sample set, which show that the sample set contains more sites at the higher end of the AQ banding than the full dataset in the low EUCs. The higher EUCs also tend not to have the full range of AQs present in the full dataset represented in the sample set. The distribution of AQ in the sample set are different to the EUCs in the full dataset: There might be an impact on the model in terms of poorly representing certain types of users, or over-biasing the models towards certain types of profile. The lower EUCs in particular might benefit from a more representative range of users: further analysis in this pack will determine the impact on UIG.	The fraction of samples per EUC and occurrence of a given AQ in each EUC were plotted for both the sample and the full dataset for the 16/17 gas year. Comparing these plots will reveal the proportional makeup in terms of AQ representation of the sample set and the full market – ideally they should have similar patterns.

Supporting Evidence (1/3) – Representation of EUCs in the sample set





The figures on this slide show the representation of meters in different EUCs in the sample set. They have been created from the full AQ dataset for the UK in the 2016/17 gas year. The numbers for the full dataset also include the data from the sample set, as it is a subset of the full dataset.

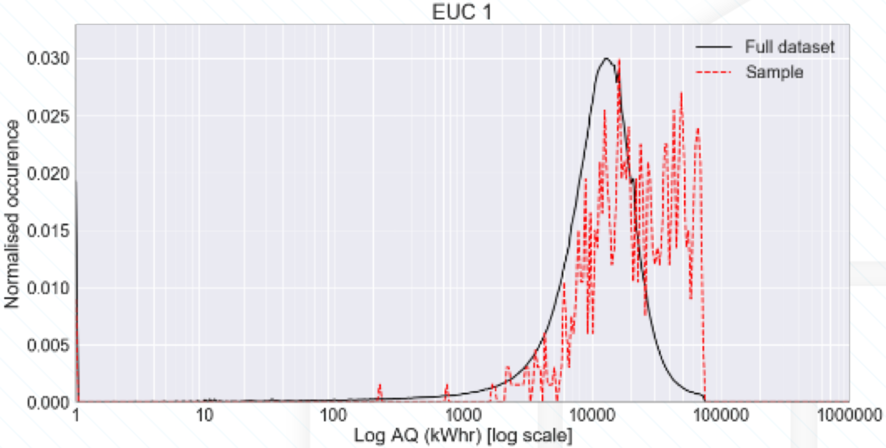
The distribution of meters in each EUC is much flatter in the sample set than the full dataset (i.e. more consistent sample size across all EUCs). The *top left* figure shows the logarithm of the fraction of the total number of meters in each EUC in both the sample set (red) and the full dataset (black) – the sharper decline with increasing EUC in the full data set shows that the fraction of meters in the lower EUCs is much smaller in the sample set than the full data set.

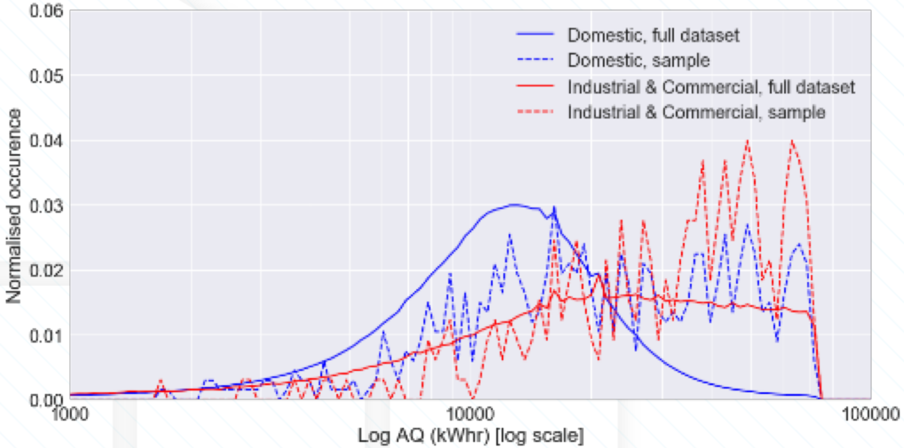
The *bottom left* figure shows the percentage of the meters in the full dataset which are present in the sample set, split by EUC, for each LDZ and the whole of the UK. This percentage is a direct measure of the representation of each EUC in the sample. As seen in the previous plot, the percentage increases with increasing EUC, with almost 60% of the highest EUCs (8 & 9) in the sample. The percentage of meters from EUC 1 in the sample is particularly low, at an average of around 0.04%.

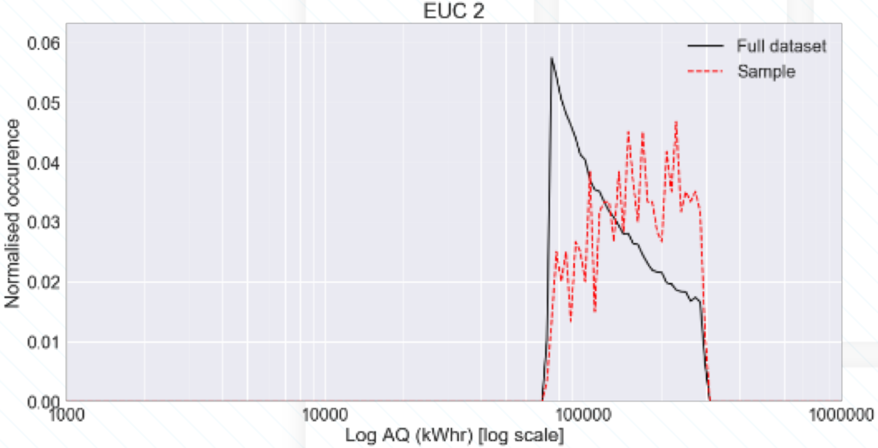
The higher representation of the higher EUCs in the sample set is expected, as there are increasingly few meters with higher EUCs, so a greater fraction of the overall data set is required in order to have sufficient data to build an accurate model of demand. However, the fraction of meters in EUC 1 is extremely low, as well as being the largest and most diverse EUC, meaning it is likely not sufficiently well represented in the sample. Although the number of meters in EUC 1 is significantly higher than the other EUCs, the absolute number of samples per LDZ is still relatively low, as only around 1 in 2,500 meters is in the sample, meaning the total number per LDZ is only hundreds.

As the EUCs in each LDZ are modelled separately, the absolute representation of a given EUC is more important than the relative representation. The very low representation of EUC 1 may mean poor representation of the variation in full sample, meaning the NDM Algorithm may not allocate all types of user in this EUC appropriately.

Supporting Evidence (2/3) – Representation within EUCs in the sample set





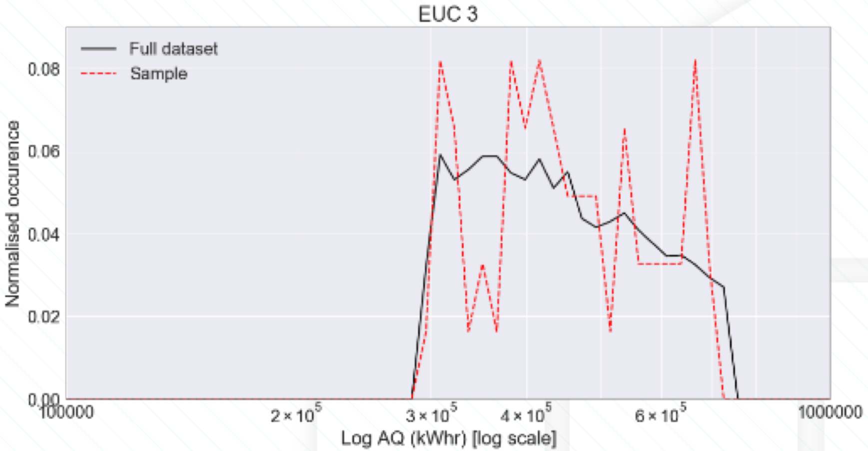


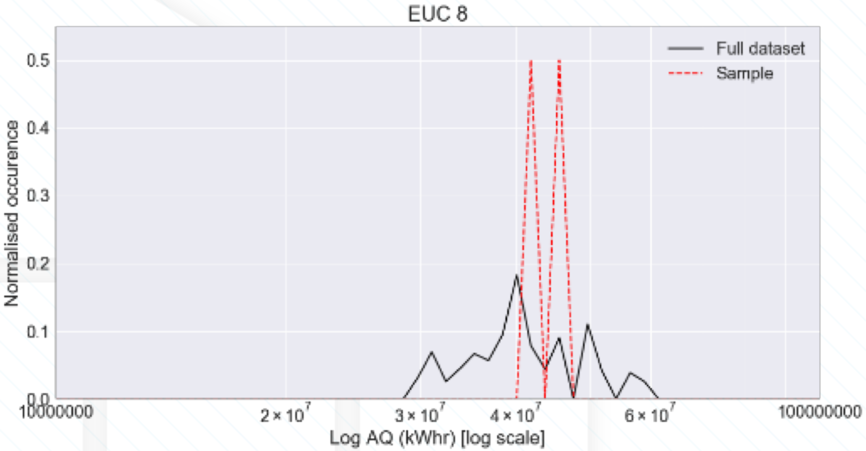
The figures on this slide and the next slide show the distribution of occurrence of different AQs in the full data set (black) compared to the sample set (red), for selected individual EUC. As on the previous slide, they have been created from the full AQ dataset for the UK in the 2016/17 gas year.

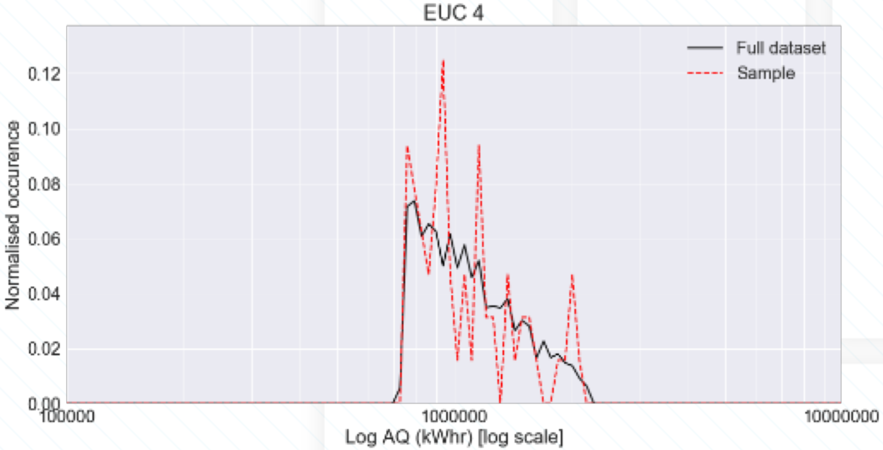
The AQ distributions for the individual EUCs tend to be less representative for the lowest EUCs and highest EUCs, and more representative for the intermediate (e.g. Bands 3-6) EUCs.

The *left top* and *left bottom* figures show the AQ distributions for EUCs 1 and 2, respectively. Both show that proportionally the sample contains significantly more meters at a higher AQ than those in the full data set. This does not seem to be driven by industrial and commercial users in EUC 1, as demonstrated in the *top right figure* – the industrial meters are well-represented, but the domestic meters are not.

Supporting Evidence (2/3) – Representation within EUCs in the sample set







The *left top* and *left bottom* figures shows the AQ distributions for EUCs 3 and 4.The sample distributions are similar to that of the data set in this instance and therefore likely to be representative of the meters in these EUCs. All intermediate EUCs (3-6) show the sample to be representative of the full dataset in this way.

The *right top* figure shows the AQ distribution for EUC 8.The sample distribution is very spikey due to the low number of meters in the sample set at this EUC, making it difficult to be representative, however the sample clearly lacks the range of AQs present in the full data set. The other high EUCs (7-9) show a similar lack of coverage of the full dataset AQs in the sample.

The difference in the AQ distributions at high and low EUCs is potentially problematic. Although the predicted usage is scaled with AQ, it is likely that the average demand profile changes with AQ. By using samples with an AQ distribution that differs from the full dataset, it is therefore likely that the modelled profile for a given EUC will not be representative of the sample as a whole, leading to errors in the predicted demand.

13.3.1: Accuracy of NDM Algorithm - NDM Sample Data - Representation across EUCs

Use existing demand estimation model with corrected EUC 1 AQ weightings

Summary of Findings

Area & Ref #	Accuracy of NDM Algorithm - NDM Sample Data - Representation across EUCs (Ref# 13.3.1)
UIG Hypothesis Specific Item	The analysis in the previous slides revealed that it is possible that some sites are under or over represented within the sample data set leading to modelling problems within the current demand estimation model. This problem could be addressed by rebuilding the current demand estimation model according to the existing process, but by 'weighting' the sample data set so that it better represents the full meter population.
Data Tree References	EUC, WAALP

Findings Status	[Closed]
UIG Impact Peak Volatility %	<1%
UIG Impact Annual Average %	0%
Confidence in Percentages	High

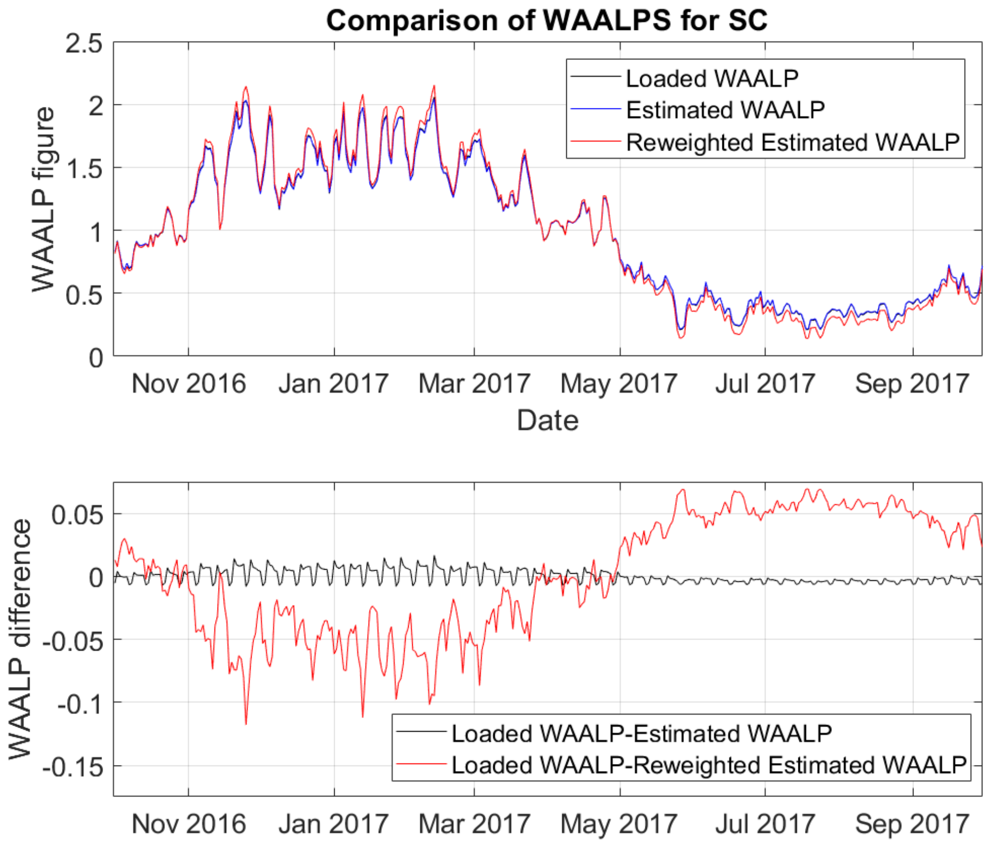
Findings	Approach to analysis
We have applied weighted EUC Band 1 Domestic data with the existing demand estimation model to see if we can improve the accuracy of daily NDM allocation; our findings do not show any significant benefits. It may be possible that there is too much variation within EUC 1 sites for the current model to be effective and that if EUC 1 is broken up into ‘sub-EUCs’ the current demand estimation model might be able to better model demand and reduce UIG and/or UIG volatility. • WAALPs produced using re-weighting coefficients tend to reduce demand in the summer and increase demand in the winter • Using the new model, the maximum peak volatility reduction would be <1% UIG (LDZ EA, as an example, showed improvement to UIG peak reduction of 0.6%).	For Domestic users EUCs 1, the demand estimation process was recreated, using the sample set data from 2013-2016 to predict demand in Gas Year 2017. Re-weighting coefficients were estimated for each LDZ by comparing the total sample set demand in each of 5 sub-bands of EUC1 to the total LDZ population AQ in the same sub-bands. These were used to modify the demand in the sample set – making the daily demand profile better representative of the EUC1 population as a whole. The demand estimation process was repeated with the reweighted demands, and their performance at modelling on both the sample set whole population was considered This will produce sample demand error performance, using the corrected weightings, on the sample dataset calculated for EUC 1 and at least 3 LDZs, compared to the current sample demand error performance.

Supporting Evidence (1/3) – Validity of re-modelling

We attempted to recreate the NDM factors as closely as possible for this analysis, but data for a very small number of sample meter points data was not available for the re-modelling. >95% of the same sample meter points used to create these weighted models, but some differences were expected in the recreated like-for-like WAALPs.

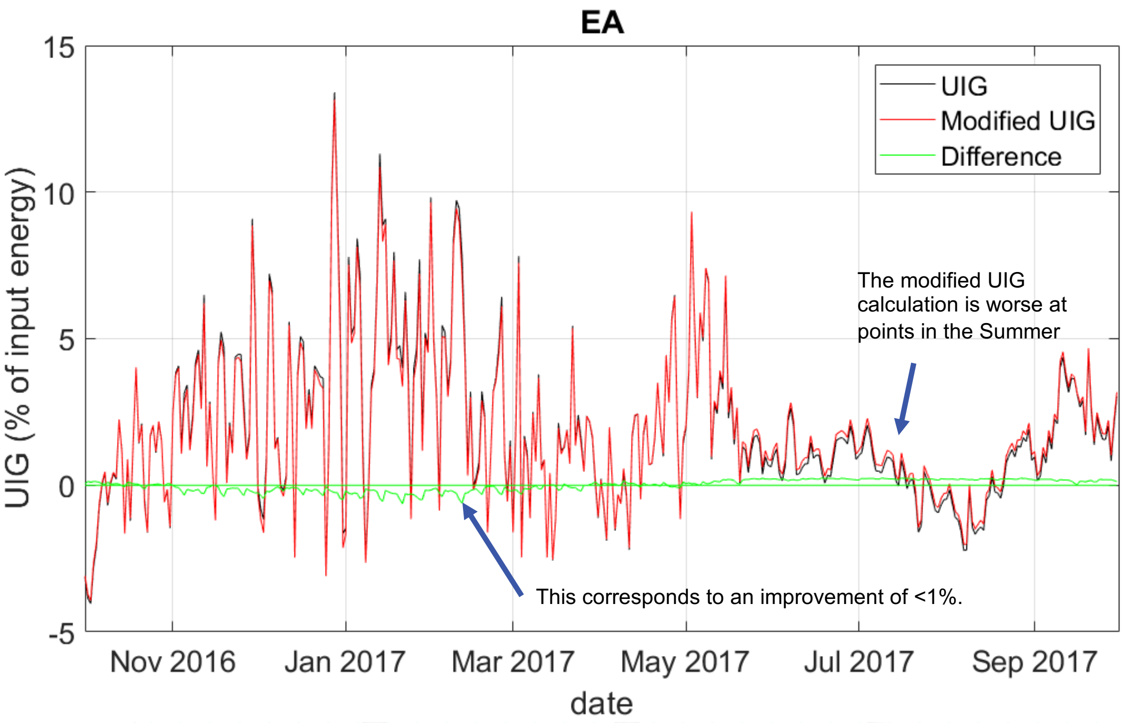
The like-for-like WAALPS produced by the remodelling were a very close match for the production WAALPS used for Gas Year 2017 – peak errors were <1.6% of the used WAALP in the summer and <0.6% in the winter – mainly due to small inconsistencies on weekend days illustrated by the black series on the bottom chart.

In contrast the remodelled WAALPS using the weighted sample (red series in the bottom chart) differed by up to 6% in the summer and 3% in the winter from the used WAALP, and these differences tend to roughly track demand. In general. the remodelled WAALPs lead to higher demand in winter and lower demand in summer.



Supporting Evidence (2/3) – UIG

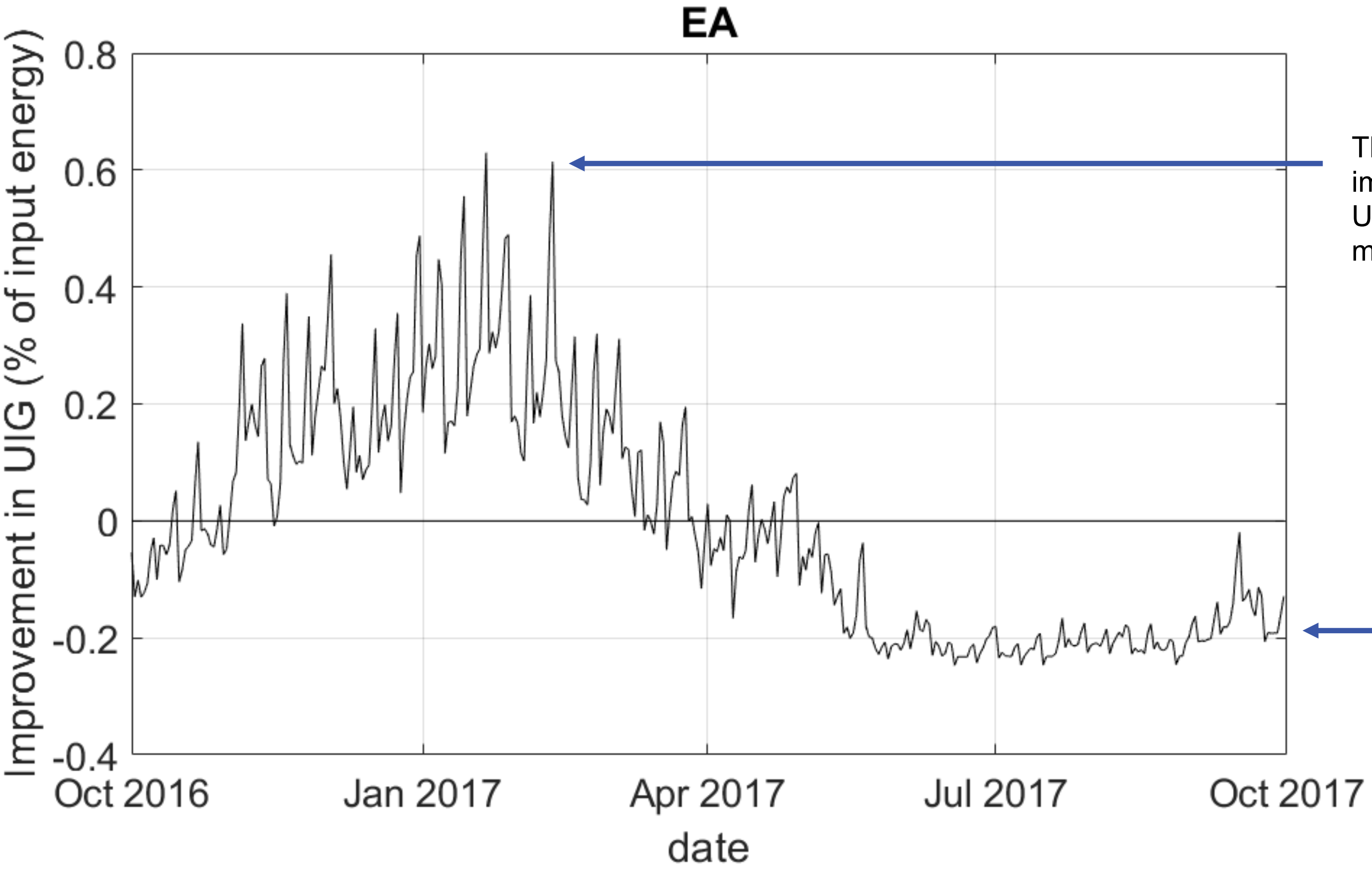
There is a reduction in UIG volatility as a standard deviation in most LDZs (notably excluding Scotland), with reductions of up to 10% of the existing level. Average reductions are around 3%. The reduction in UIG is small in all cases.



LDZ	EA	EM	SC	SE
Original model sample UIG standard deviation (GWhr)	7.27	8.56	6.21	8.61
Weighted model sample UIG standard deviation (GWhr)	7.03	7.75	7.16	8.49
% Change	3.38	9.54	-15.34	1.37

Note: % is the change in the standard deviation of the error, and not a reduction in the peak to peak volatility

Supporting Evidence (3/4) – Improvement in UIG



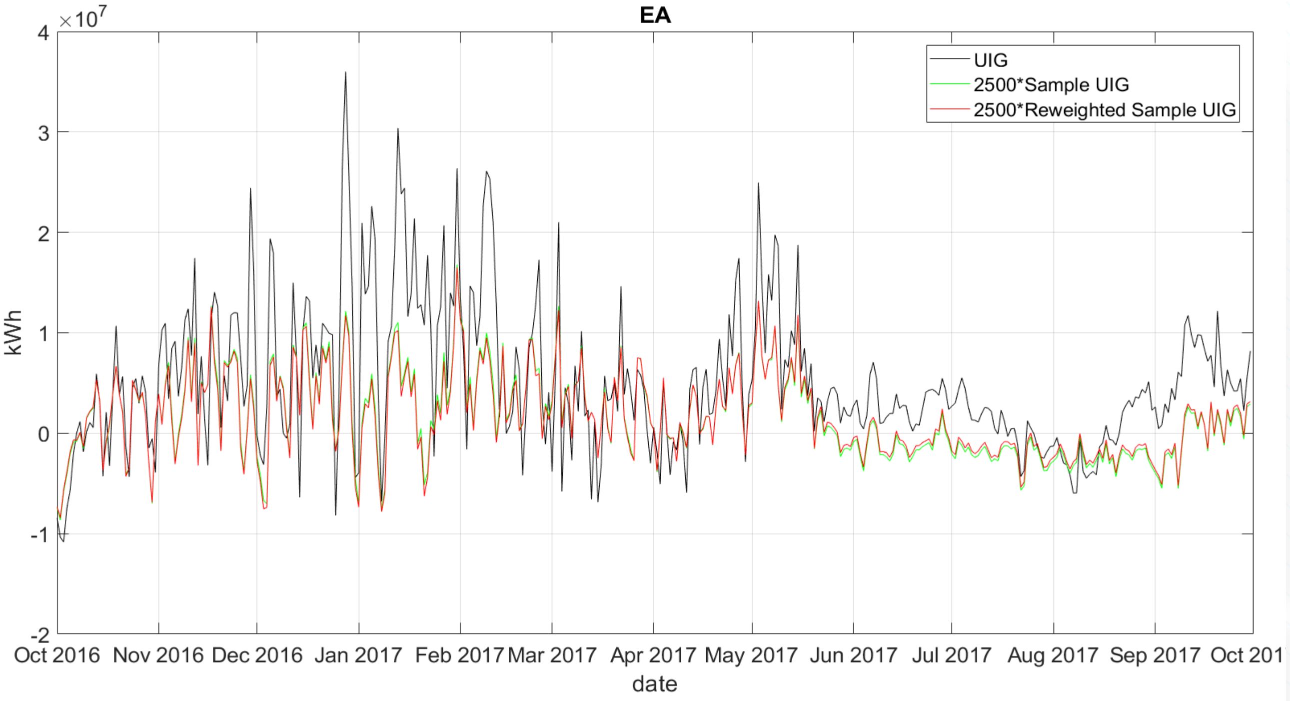
The maximum improvement in UIG using the new model is 0.6%

In Summer, the new model increases UIG by a small amount (0.2%)

Supporting Evidence (4/4) – Validity of re-modelling

In addition to the previous results, it has also been found that the UIG of the sample EUC 1 seems to track the variability of the EUC 1 UIG of the full dataset, but without some longer-term changes.

This implies that the variability in the full data set is fairly well-represented in the sample data, but that there may be some extra factors not present in the sample set, which is causing variability over longer timescales time in the full dataset.



13.3.1: Accuracy of NDM Algorithm - NDM Sample Data - Representation across EUCs

Existing NDM modelling broken down by EUC 1 sub bands

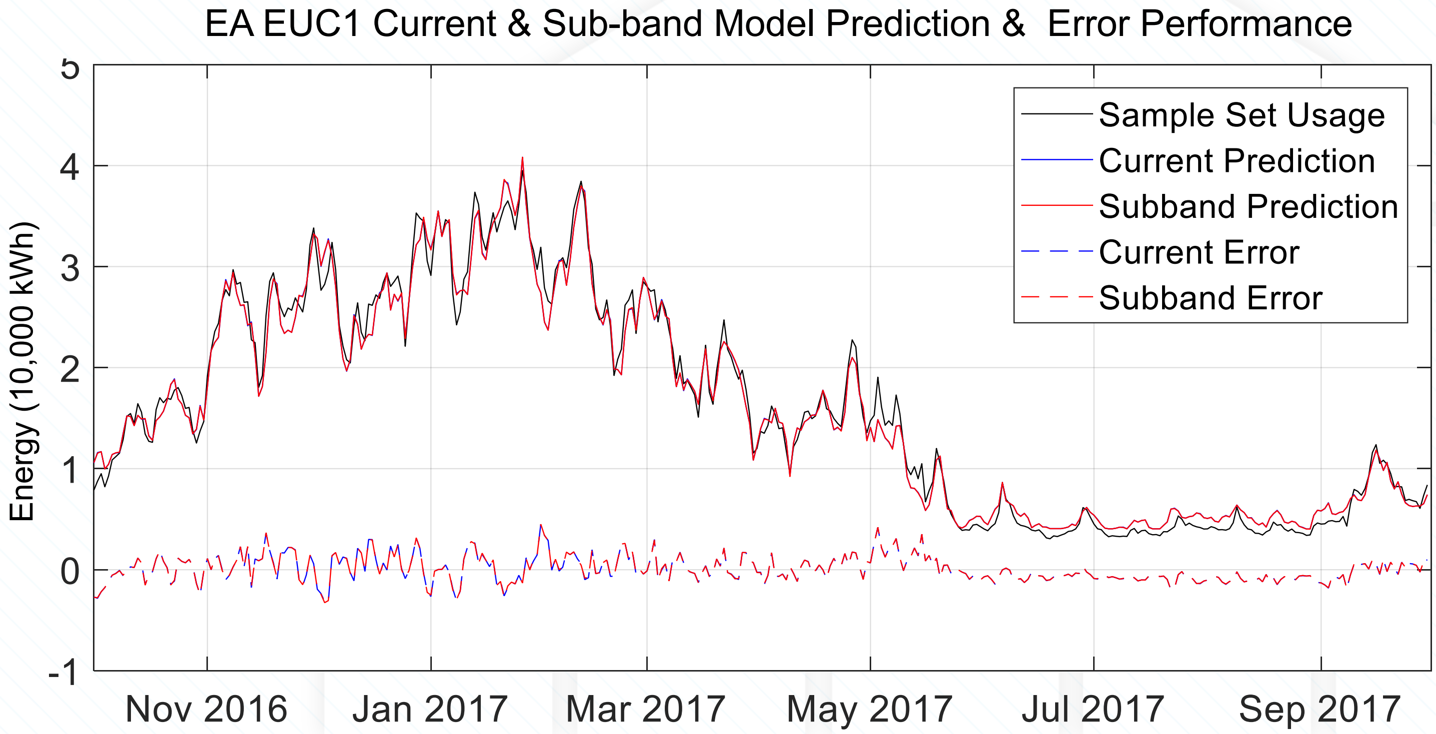
Summary of Findings

Area & Ref #	Accuracy of NDM Algorithm - NDM Sample Data - Representation across EUCs (Ref #13.3.1)
UIG Hypothesis	It is possible that there is too much variation within EUC1 sites for the current model to be effective and that if EUC1 is broken up into 'sub-EUCs' the current demand estimation model might be able to better model demand and reduce UIG and/or UIG volatility.
Data Tree References	EUC, WAALP

Findings Status	**[Closed]**
UIG Impact Peak Volatility %	**~0%**
UIG Impact Annual Average %	**~0%**
Confidence in Percentages	**H**

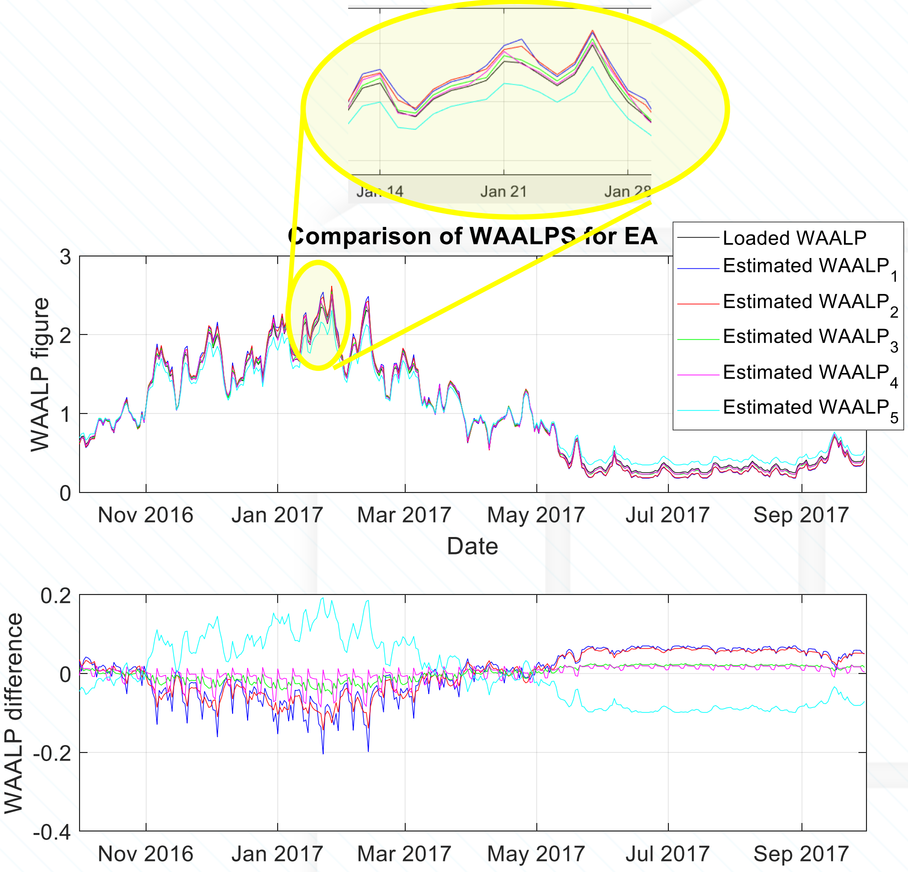
Findings	Approach to analysis
The meter points within different sub-bands in EUC1 have different sensitivity to CWV, but these differences do not lead to a significantly better prediction of aggregate demand. The overall modelling of the sample data is almost the same if sub-band modelling is used or not. It is not yet clear if it would make a difference to the overall UIG (due to the difference in proportions of each sub-band in the sample set as compared to the whole data set). Using the sub band EUCs may reduce the levels of energy reconciled for meter points with different AQ levels and so we have shared these findings with the Demand Estimation team for assessment at the Demand Estimation Subcommittee. As the number of sample sites available in EUC01 is already small, subdividing the sample into smaller partitions in each sub-band can lead to difficulties in the modelling as there are very few data points available to model the demand relationships with weather.	The current Domestic EUC1 demand modelling process was duplicated on sub-bands of the sample data, producing a set of WAALPs for each of 5 different sub-bands in EUC1 (see below). These were compared to the WAALP produced by the current process- both directly and in terms of their impact upon the error performance on the NDM sample dataset. The sub-band boundaries used were 0, 7320.0, 13017.0, 23147.9, 41163.4, 73200.0. These led to reasonably sized samples – for example for EA the number of meter points in each sub-band was 43, 107, 106,41 and 28 respectively.

Supporting Evidence (1/4) – Model Error Performance Comparison (East Anglia)



These two lines indicate that there is negligible difference between the current and sub-band model: the error between the modelled and the measured usage is the same (i.e. the East Anglia EUC1 sample set UIG)

Supporting Evidence (2/4) – Comparison of sub-band WAALPS with the current WAALP



These figures show that the WAALPs produced for the different sub-bands are generally very similar to each other, however they do all differ slightly. The main differences are either increased demand in the winter and decreased demand in the summer or vice-versa.

- E.g. WALLP for sub-band 1 shows increased demand in the winter and decreased demand in the summer . WAALP for sub-band 5 shows the reverse.

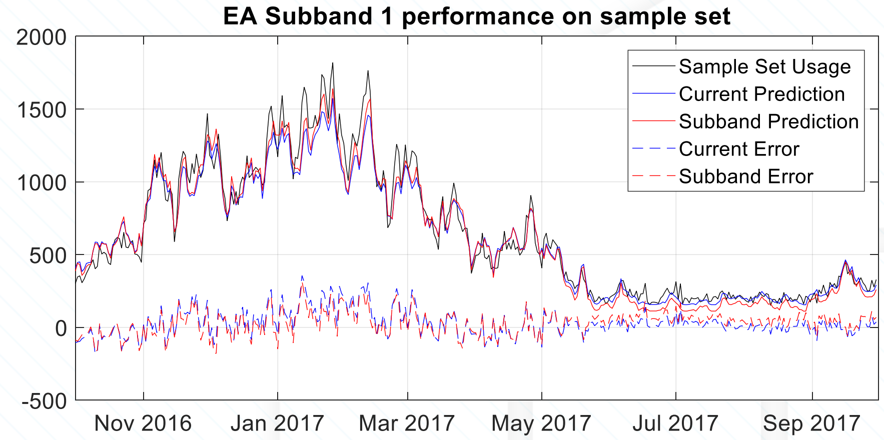
In general the overall effects are much less significant than the basic shape of the CWV – as all WAALPS produced by this method are essentially scaled and offset variations on the CWV line this is not surprising.

The most significant differences are due to different summer reductions and CWV sensitivity in the different sub-bands. These lead to the different summer demands, and, through the normalisation of the ALPS, the inverse differences in demand in the winter. The table below shows the EA CWV sensitivity in terms of the CWV value where demand is at it's minimum level. It is clear that sub-band 5 is quite different and reduces demand to minimum when the CWV is around 1 degree higher than the other sub bands.

Sub-band / Test year	1	2	3	4	5
2013-2014	18.0	18.1	18.2	18.4	19.8
2014-2015	17.7	17.7	18.3	18.4	19.5
2015-2016	18.0	17.9	18.8	19.0	20.0

Smaller differences in the day-of-week models can be seen, but these are much less significant.

Supporting Evidence (3/4) – Contributions of EUC 1 sub-bands to sample set error

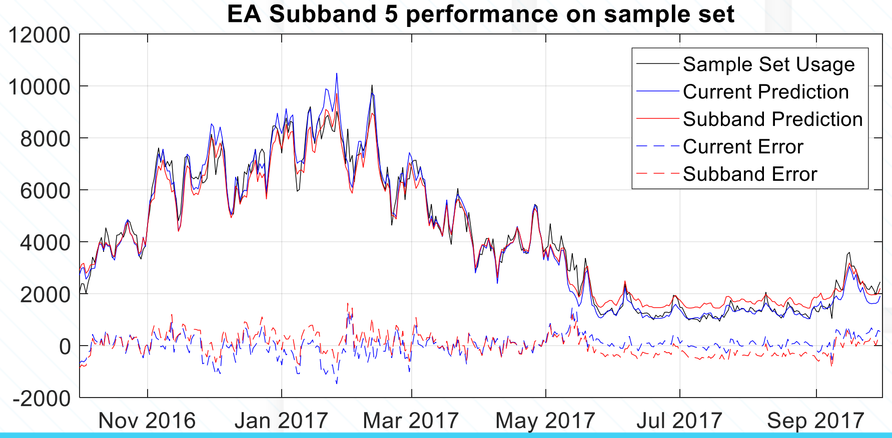


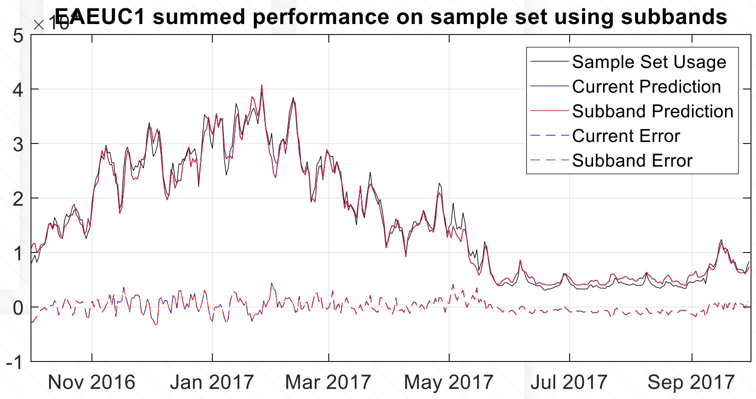
These two graphs show the different behaviours of the sub-bands 1 and 5 WAALPS when used to predict the 2016-17 demand on the sample set (solid lines) and their error (dotted lines).

They both demonstrate that the scaled CWV plots are limited in their ability to predict demand perfectly.

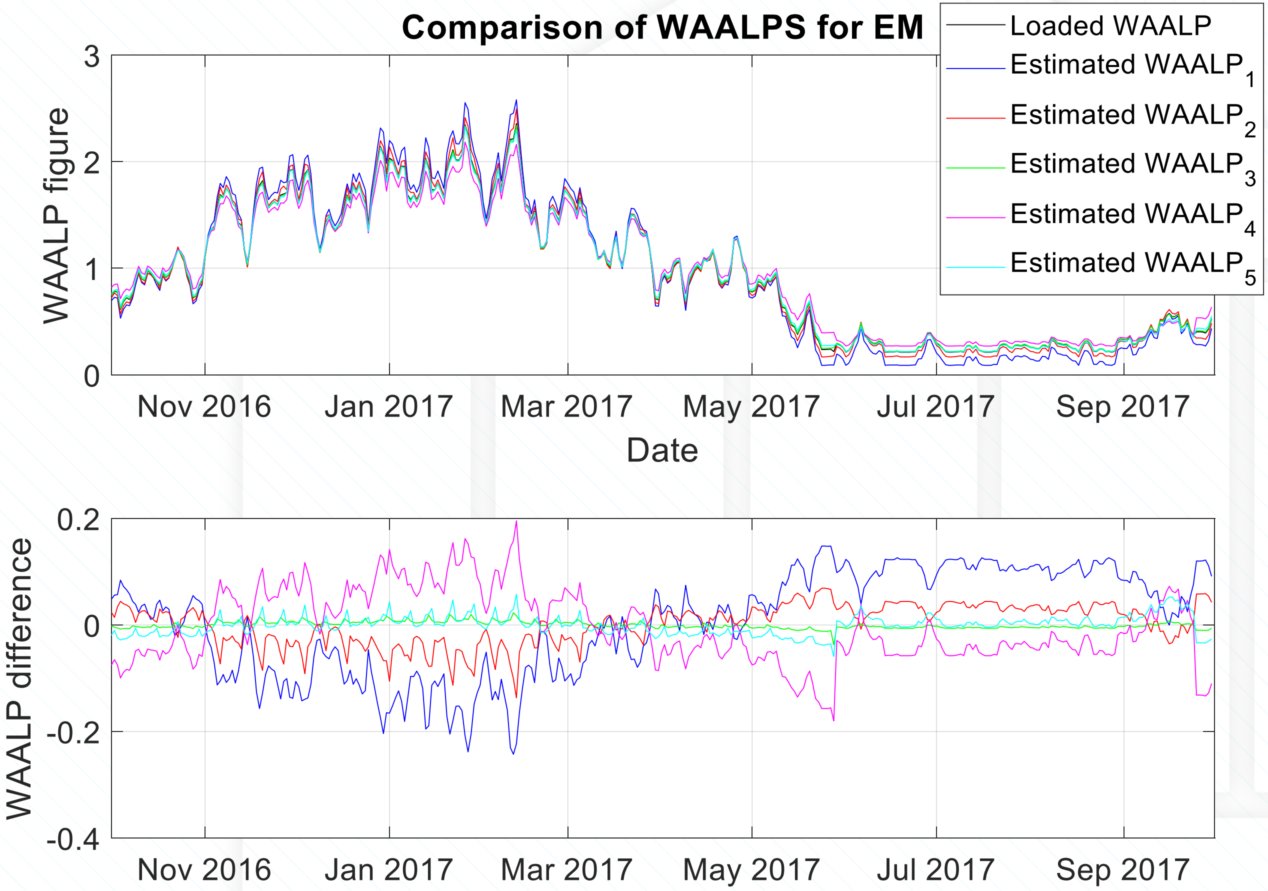
These both show significant differences in the sub-band predictions ability to determine suitable summer multipliers. This may be because the sample set has changed significantly in size (grown by about + 60%) from the three training years to the test year.

The final plot below shows that the EUC 1 performance (summed over all sub-bands) is almost the same.





Supporting Evidence (4/4) – Comparison of sub-band WAALPS with the current WAALP – EM



These figures show that the WAALPs produced for the different sub-bands are generally very similar to each other and that this continues for EM LDZ.