5.1 Model Smoothing Review Supporting Document

1. Background

Model Smoothing was introduced to the NDM Modelling process in 1999 and has been reassessed regularly since, most recently in 2020.

This review is a full formal assessment of the model smoothing process in line with earlier reviews.

Note, due to changes in the grouping for WAR Bands, the results are not on the same basis year-on-year. Band 9 is no longer modelled and has therefore been excluded from the results.

2. Principles of Model Smoothing

Model smoothing was introduced because EUC models were showing some year-on-year Volatility. It was therefore predicted that averaging more than one year's models would achieve greater stability.

A further aim of the EUC models is that of improved accuracy, however, the two goals of stability and accuracy are not necessarily consistent: if there is an underlying drift in customer behaviour which leads to changes in model characteristics then stability may be achieved at the expense of accuracy.

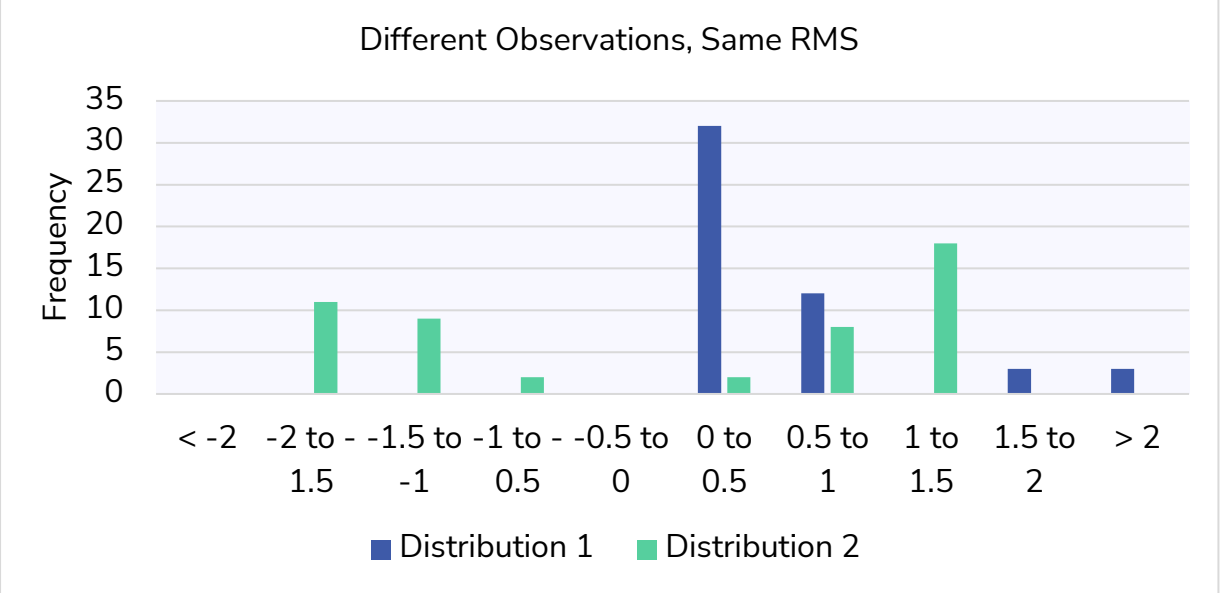
It is proposed here, as in all earlier reviews, that accuracy is defined as the capability of a model (or a smoothed model) to predict the model that will be fitted to the following year's data.

3. Analysis

The main measure used is the Root Mean Squared (RMS) which gives a view of how widespread any variance is, i.e., how many of the models are showing a difference and the extent of the difference. It is worth also looking at the values on a bar chart, as distributions with the same RMS can be quite different.

e.g., In the following example chart, Distribution 1 is skewed with most values clustered slightly positive, with some more extreme outliers. Distribution 2 values are on average much closer to zero with a more even positive and negative spread.

Example 1. Same RMS for Different Distributions



The RMS is used in analysing the Predictive Ability of the models and the Volatility of the models.

The other analysis is Trend Analysis which looks at the change in CWV intercept over time. Trend analysis is used to help determine if smoothing using averaging or model extrapolation is a more Predictive approach.

3.1 Analysis Periods

The table below outlines the periods which have been used for the analysis. Note the different years in the Smoothed Models for 01BND; in 2021 DESC decided that due to the impact of COVID-19 lockdowns on the sample data, only 01BND would use the sample data for 2020/21.

Figure 1. Analysis periods

Single Year Datasets			Smoothed Model
Year	01BND*	All other EUCs	
Year 1	2020/21	2019/20	For Gas Year 2023/24
Year 2	2021/22	2021/22	
Year 3	2022/23	2022/23	
Year 1	2019/20	2018/19	For Gas Year 2022/23
Year 2	2020/21	2019/20	
Year 3	2021/22	2021/22	

The datasets used varies for each of the different analysis and these are outlined at the beginning of each section.

3.2 Analysis Data

Small NDM

78 EUCs are included in the Analysis for small NDM,

- 13 LDZs for each of 01BND, 01BNI, 02BND, 02BNI, 03B and 04B
- Analysis is not possible at present for the Prepayment EUCs (01BPD, 01BPI, 02BPD and 02BPI)
  - 01BPD modelling used MOD451AV data (from 2012/13), until Gas Year 2021/22 when Class 3 data was introduced, Model Smoothing for 3 years of class 3 data will be from 2023/24
  - The meter count is insufficient for modelling 01BPI, 02BPD and 02BPI
- WAR Bands have been looked at separately due to changes in the grouping used for modelling

Large NDM

52 EUCs are included in the analysis for Large NDM

- 13 LDZs each for 05B, 06B, 07B and 08B
- WAR Bands have been looked at separately due to changes in the grouping used for modelling
- Band 9 EUCs are not modelled and have therefore been excluded

WAR Bands

312 EUCs are included in the analysis for WAR Bands

- 13 LDZs each for Bands 03, 04, 05, 06, 07, 08 for War Bands 01-04
- The following changes were introduced for Modelling Gas Year 23/24 which means the results are not directly comparable:
  - WAR Bands for EUC Bands 3 and 4 are modelled separately, where they were previously grouped
  - WAR Band modelling for EUC Band 5 is unchanged
  - WAR Bands for EUC Bands 6, 7, and 8 are now grouped with Band 5 Data for modelling, previously EUC Band 6 was modelled separately and Bands 7 and 8 were grouped
- As we expect changes to the modelling methodology from time to time, it is still worth considering the analysis

3.3 Volatility Analysis

The two tests for the Volatility Analysis are:

1. **Single Year Test** – Compares CWV Intercepts for Year 3 (2022/23) against Year 2 (2021/22) for Gas Year 2023/24 showing the year-on-year change

2. **Smoothed Model Test** - Compares CWV Intercepts for the Smoothed Model for Gas Year 2022/23 against the Smoothed Model for Gas Year 2023/24 showing the year-on-year change between Smoothed Models

Figure 2. Volatility Analysis periods

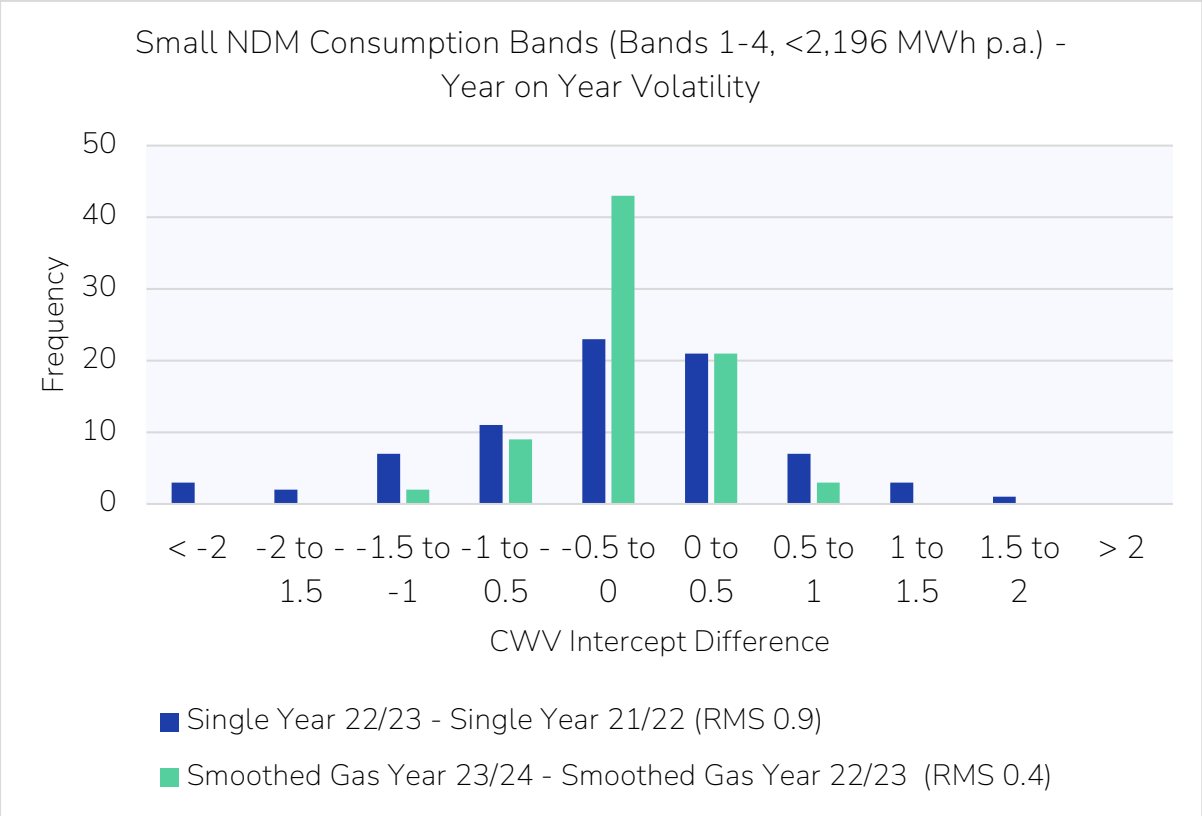
Single Year Datasets			Smoothed Model
Year	01BND*	All other EUCs	
Year 1	2020/21	2019/20	For Gas Year 2023/24
Year 2	2021/22	2021/22	
Year 3	2022/23	2022/23	
Year 1	2019/20	2018/19	For Gas Year 2022/23
Year 2	2020/21	2019/20	
Year 3	2021/22	2021/22	

*DESC agreed in 2021 that due to the impact of COVID-19 lockdowns on the sample, only 01BND would use the data for 2020/21

Small NDM Volatility

78 Small NDM (<2,916 MWh p.a.) EUCs were analysed. The Smoothed Model Test shows a smaller RMS and much closer distribution of values. The Single Year Test shows higher year-on-year Volatility.

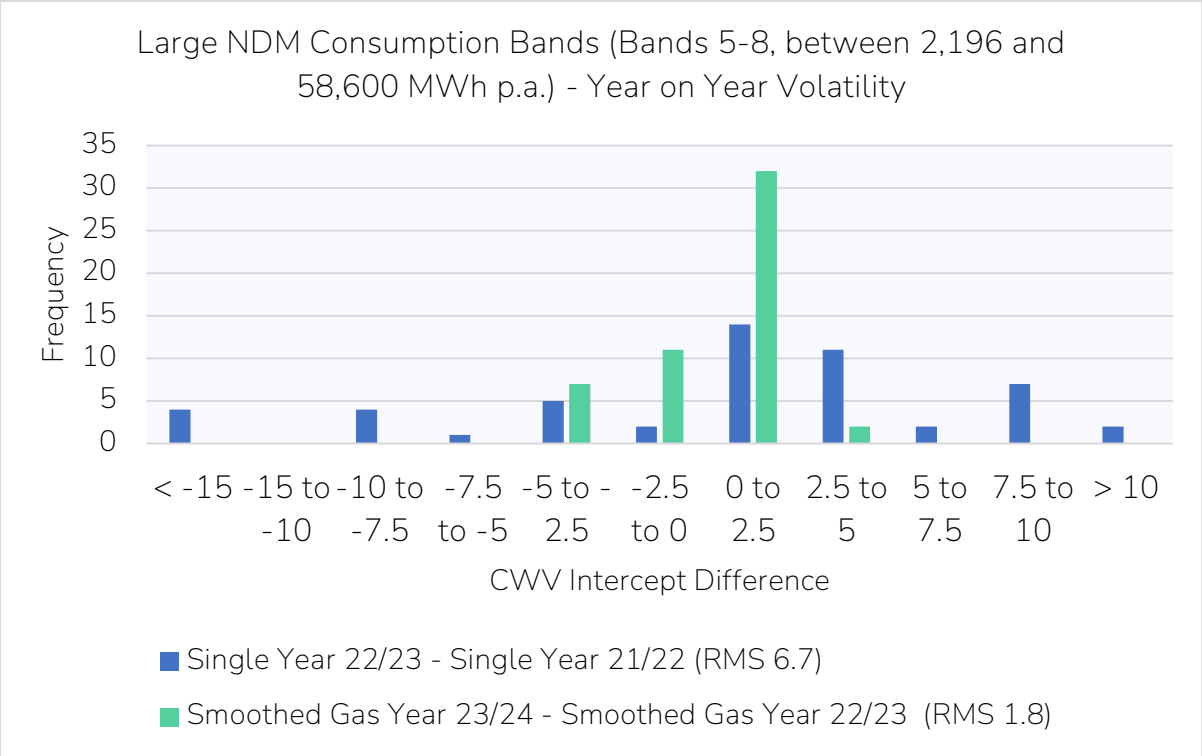
Figure 3. Small NDM Volatility



Large NDM Volatility

52 Large NDM (>2,196 MWh p.a.) EUCs were analysed. The Smoothed Model Test is much less volatile, with a significantly lower RMS and most year-on-year changes in CWV Intercept close to zero.

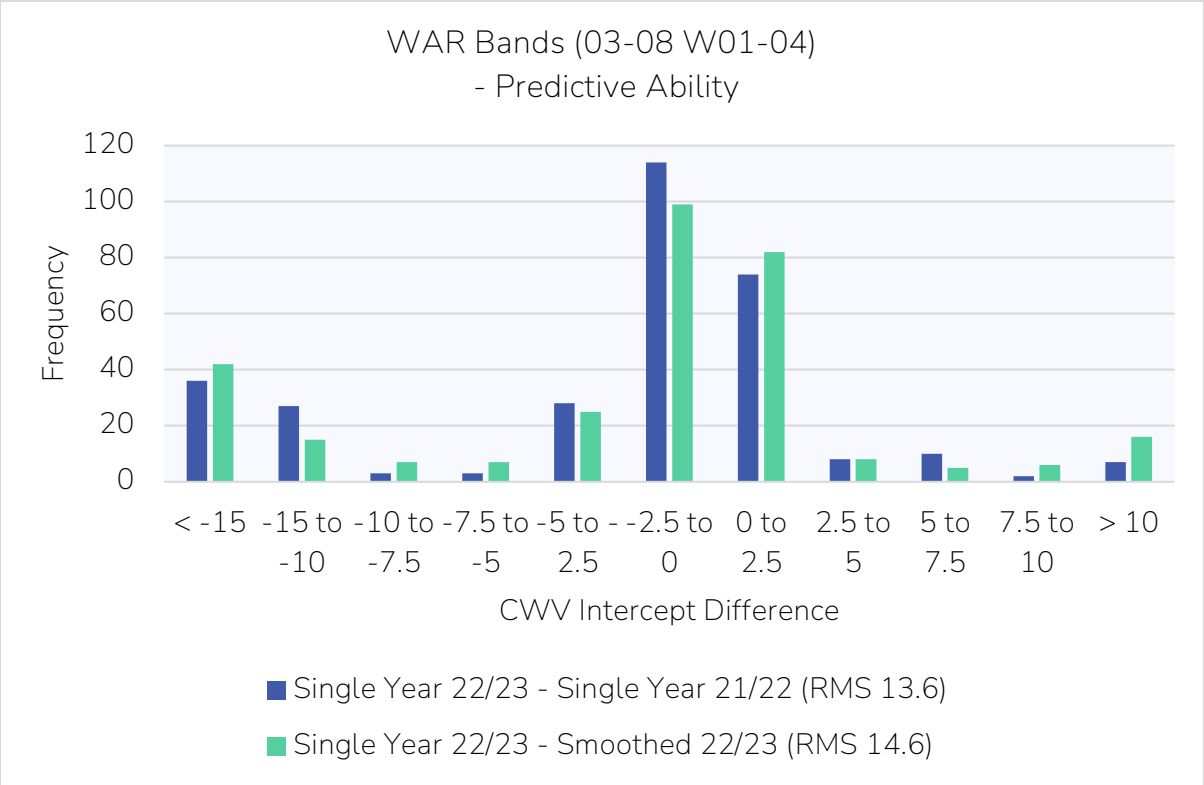
Figure 4. Large NDM Volatility



WAR Band Volatility

Again, for the 312 WAR Bands analysis is less reliable due to changes in the grouping used for modelling. The RMS For the Smoothed Model Test is quite a bit lower than the Single year test, suggesting that despite the changes, the Smoothed Model is less volatile.

Figure 5. WAR Band Volatility



3.4 Predictive Ability Analysis

The two tests for the Predictive Ability Analysis are:

1. **Single Year Test** – Compares CWV Intercepts for Year 3 (2022/23) against Year 2 (2021/22) for Gas Year 2023/24 showing the year-on-year change

2. Smoothed Model Test - Compares CWV Intercepts for Year 3 (2022/23) against the Smoothed Model for Gas Year 2022/23 showing the difference between the latest Single Year and the Smoothed Model

Figure 6. Predictability Analysis Periods

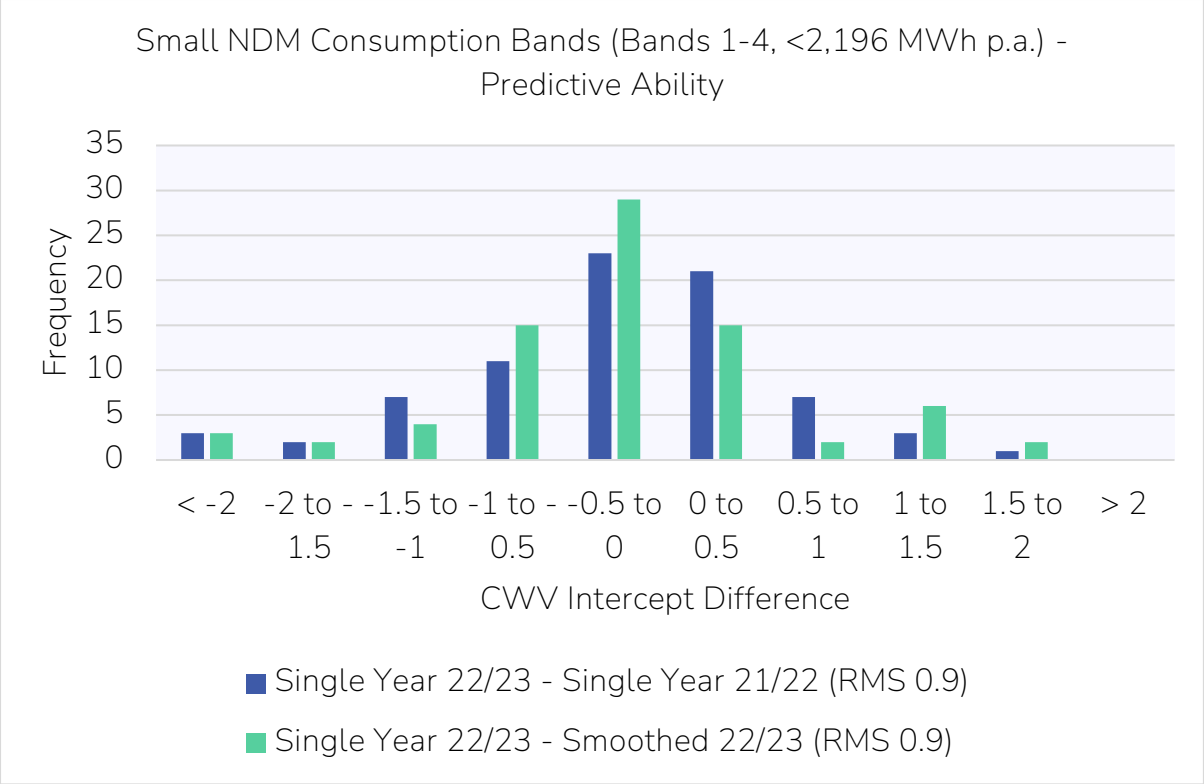
Single Year Datasets			Smoothed Model
Year	01BND*	All other EUCs	
Year 1	2020/21	2019/20	For Gas Year 2023/24
Year 2	2021/22	2021/22	
Year 3	2022/23	2022/23	
Year 1	2019/20	2018/19	For Gas Year 2022/23
Year 2	2020/21	2019/20	
Year 3	2021/22	2021/22	

*DESC agreed in 2021 that due to the impact of COVID-19 lockdowns on the sample, only 01BND would use the data for 2020/21

Small NDM Predictive Ability

78 Small NDM (<2,916 MWh p.a.) EUCs were analysed. There is little difference between the Single Year Test CWV intercept comparison and the Smoothed Model Test CWV Intercept comparison. Figure 6 below shows the distribution of the difference in CWV intercepts for the Single Year Test and the Smoothed Model Test. The Root Mean Squared is the same for both models, suggesting there is no difference in Predictive Ability between the models.

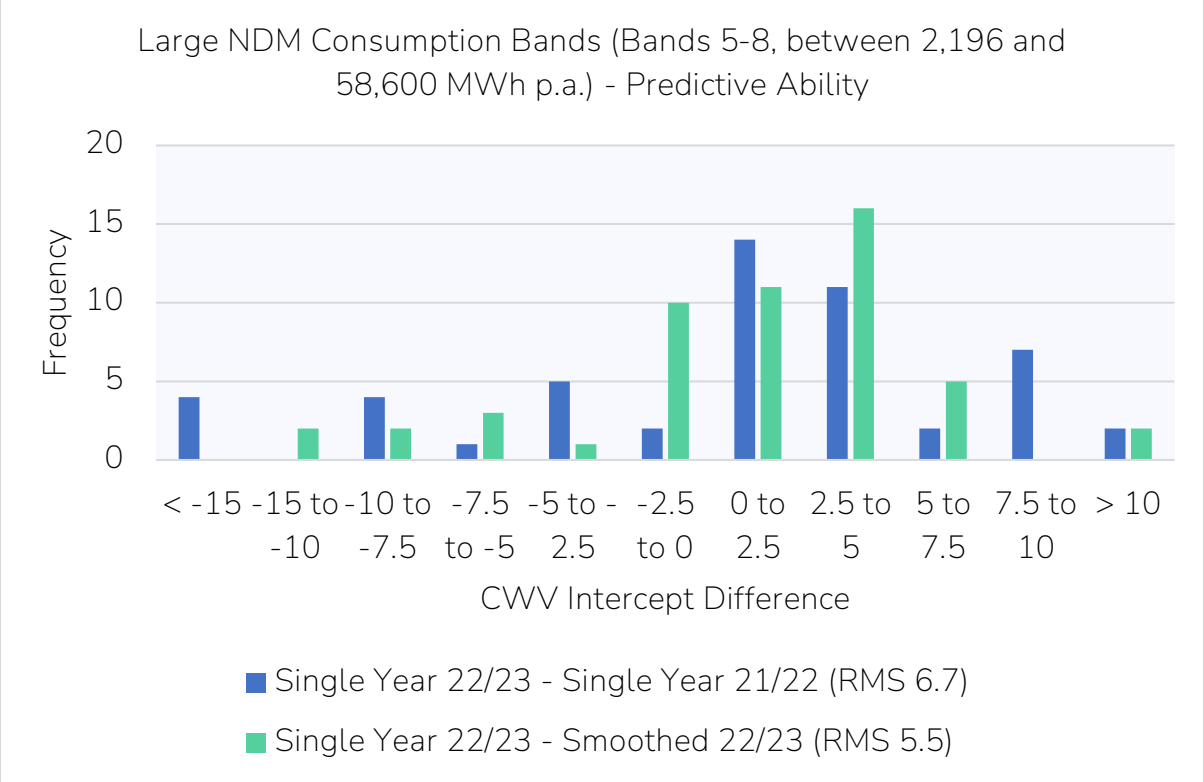
Figure 7. Small NDM Predictive Ability



Large NDM Predictive Ability

52 Large NDM (>2,196 MWh p.a.) EUCs were analysed. The Single Year Test is showing a lower Predictive Ability, with a higher RMS and 4 models showing a significant variance in CWV Intercept. The Smoothed Model has a lower RMS and 2 models showing a significant variance in CWV Intercept.

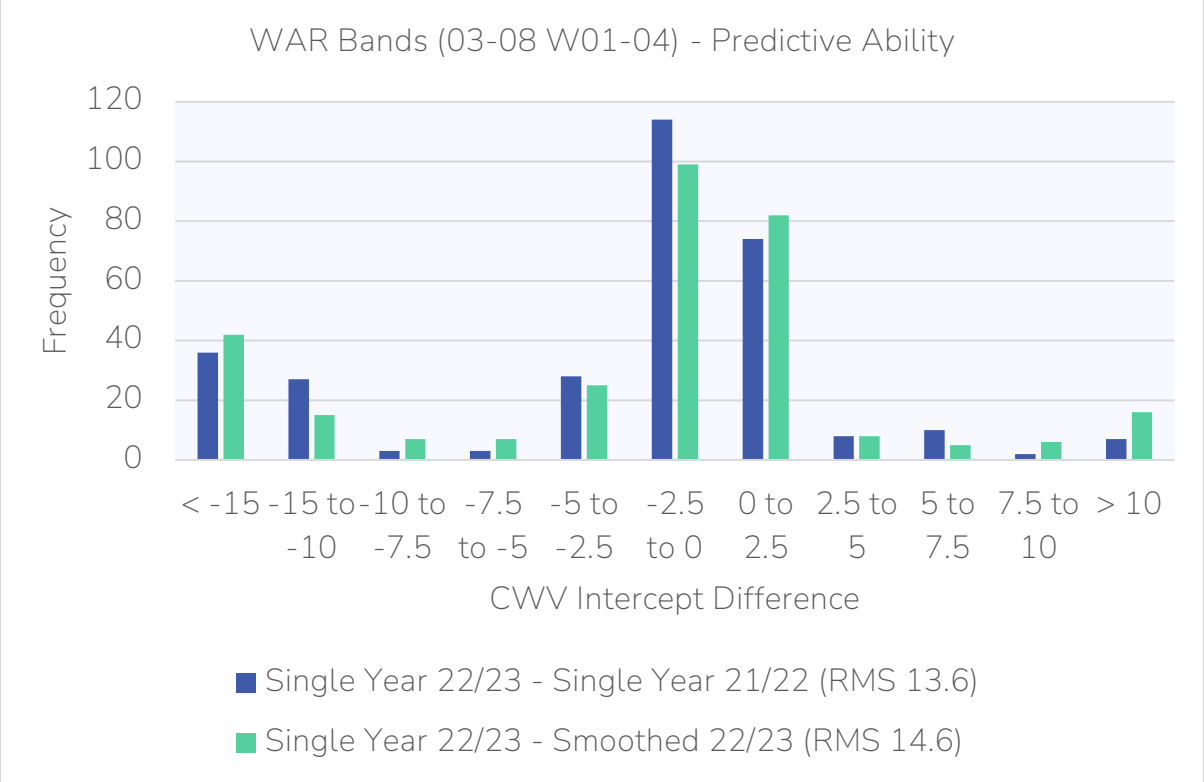
Figure 8. Large NDM Predictive Ability



WAR Band Predictive Ability

For the 311 WAR Band EUCs, results are harder to interpret as the basis for the models has changed over recent years (different bands were grouped depending on the available sample data). The results are similar, with the Smoothed Model Test having a slightly higher RMS.

Figure 9. WAR Band Predictive Ability



3.5 Trend Analysis

Trend analysis is used to aid the discussion of smoothing using averaging or model extrapolation. For extrapolation to be considered, the Trend in CWV Intercepts would need to be clearly visible in the data.

There are 4 possible outcomes from looking at the CWV Trends for the 3 years in a smoothed model. Note as with the other two analyses, the input years are different for 01BND (see 3.1 Analysis Periods)

1. Upward Trend – the CWV Intercept increases each input year.
2. Downward Trend – the CWV Intercept decreases each input year.
3. Unchanged – little to no change in the CWV Intercept (within 2% of previous year).
4. Mixed Results – The CWV Intercept changes are a mix of up and down.

Unless a clear upward or downward Trend is seen, then an averaged Smoothing Model is better than an extrapolated Smoothed Model.

The table below shows the movement Trends for the Consumption Band EUCs. Most of the models show mixed results, with no clear Trend in either direction.

Figure 10. CWV Intercept Trends by EUC Band

EUC	Down	Mixed	Up	Unchanged
01BND	6	3		4
01BNI	3	9		1
02BND	6	5	2	
02BNI	5	6	1	1
03B		6	6	1
04B		8	4	1
05B		7	5	1
06B	1	6	6	
07B		10	3	
08B		10	3	

Figure 11(on the following page) shows the same information broken down by LDZ. Again, there are no clear Trends and results are largely mixed. There are more 'Down' Trends in the lower bands and more 'Up' Trends in the higher bands, although neither is significant.

Figure 11. CWV Intercept Trends by EUC and LDZ

	EA	EM	NE	NO	NT	NW	SC	SE	SO	SW	WM	WN	WS
01BND	Unch'd	Down	Down	Mixed	Unch'd	Down	Down	Mixed	Down	Down	Mixed	Unch'd	Unch'd
01BNI	Mixed	Mixed	Down	Mixed	Mixed	Down	Mixed	Mixed	Mixed	Down	Unch'd	Mixed	Mixed
02BND	Mixed	Down	Down	Mixed	Up	Down	Down	Mixed	Mixed	Mixed	Down	Down	Up
02BNI	Down	Down	Down	Unch'd	Down	Up	Mixed	Mixed	Down	Mixed	Mixed	Mixed	Mixed
03B	Up	Mixed	Mixed	Up	Unch'd	Up	Up	Up	Up	Mixed	Mixed	Mixed	Mixed
04B	Mixed	Mixed	Unch'd	Up	Mixed	Mixed	Up	Mixed	Up	Up	Mixed	Mixed	Mixed
05B	Unch'd	Up	Mixed	Up	Mixed	Mixed	Mixed	Up	Up	Mixed	Mixed	Mixed	Up
06B	Mixed	Mixed	Up	Mixed	Mixed	Up	Up	Mixed	Down	Up	Mixed	Up	Up
07B	Mixed	Mixed	Mixed	Mixed	Mixed	Up	Mixed	Mixed	Mixed	Mixed	Up	Up	Mixed
08B	Mixed	Mixed	Mixed	Mixed	Mixed	Up	Mixed	Mixed	Mixed	Mixed	Up	Up	Mixed

Again, WAR Band analysis is harder to interpret due to changes in the Sample data grouping used for modelling. However, the view is generally mixed, with some downward movements in the lower bands and upward movements in the higher bands (reflective of the Consumption Band Movements. WAR Band 1 (least weather sensitive) is unchanged for higher EUC Bands due to the profile being flat (i.e. with no CWV Intercept calculable).

Figure 12. CWV Intercept Trends for WAR Bands

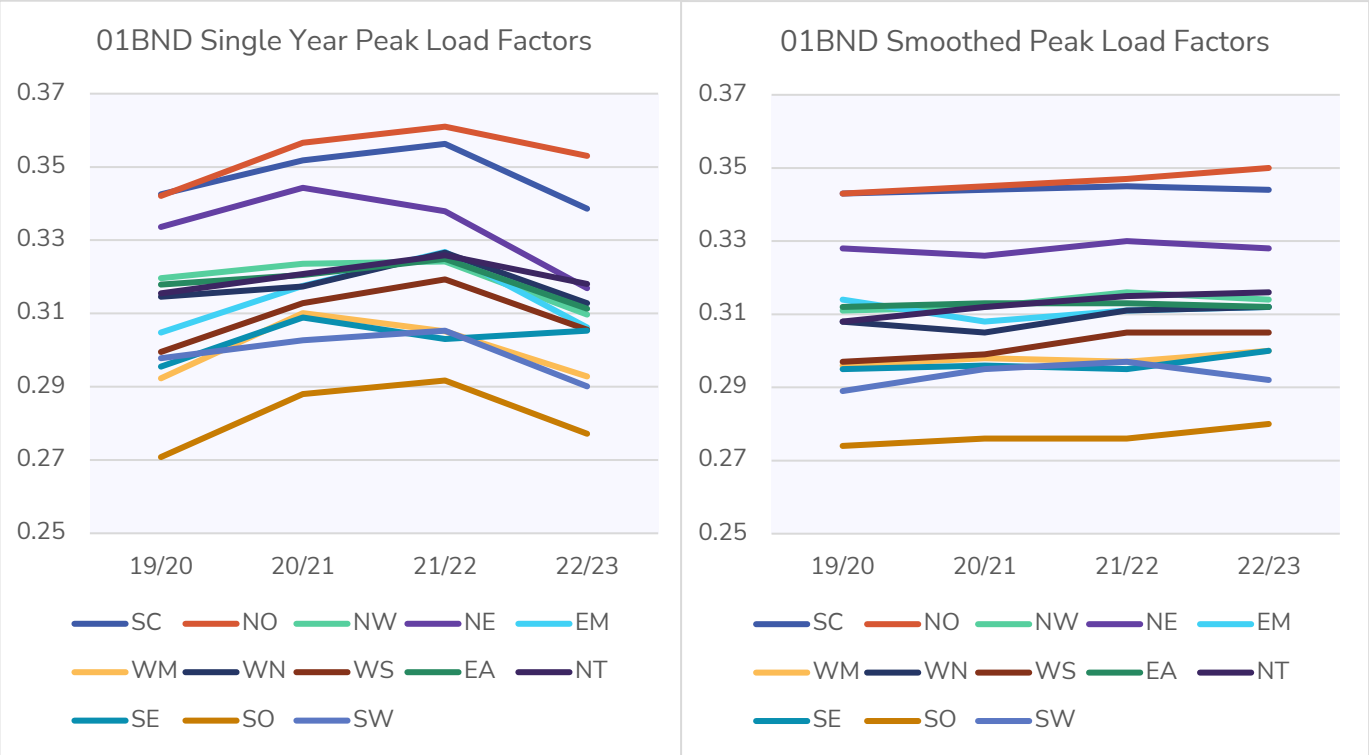
	EA	EM	NE	NO	NT	NW	SC	SE	SO	SW	WM	WN	WS
03W01	Up	Down	Mixed	Mixed	Mixed	Mixed	Mixed	Mixed	Mixed	Up	Down	Down	Mixed
03W02	Mixed	Down	Mixed	Mixed	Up	Up	Down	Up	Up	Down	Up	Up	Mixed
03W03	Mixed	Mixed	Mixed	Up	Up	Mixed	Up	Mixed	Up	Mixed	Mixed	Mixed	Up
03W04	Unch'd	Up	Mixed	Up	Mixed	Mixed	Down	Mixed	Mixed	Mixed	Mixed	Mixed	Mixed
04W01	Up	Mixed	Mixed	Mixed	Mixed	Down	Mixed	Mixed	Down	Up	Mixed	Down	Mixed
04W02	Mixed	Down	Down	Mixed	Up	Mixed	Unch'd	Up	Up	Mixed	Up	Up	Up
04W03	Up	Mixed	Mixed	Up	Up	Up	Mixed	Up	Up	Mixed	Up	Mixed	Up
04W04	Up	Unch'd	Mixed	Up	Mixed	Up	Down	Up	Up	Mixed	Up	Up	Mixed
05W01	Mixed	Mixed	Mixed	Up	Mixed	Mixed	Unch'd	Up	Unch'd	Mixed	Mixed	Mixed	Mixed
05W02	Up	Mixed	Mixed	Mixed	Up	Mixed	Mixed	Mixed	Up	Up	Mixed	Mixed	Mixed
05W03	Mixed	Mixed	Mixed	Up	Mixed	Up	Mixed	Mixed	Up	Unch'd	Up	Up	Mixed
05W04	Up	Up	Up	Up	Up	Mixed	Down	Up	Up	Mixed	Mixed	Mixed	Up
06W01	Unch'd	Unch'd	Unch'd	Unch'd	Unch'd	Unch'd	Unch'd	Unch'd	Unch'd	Unch'd	Unch'd	Unch'd	Unch'd
06W02	Mixed	Mixed	Mixed	Mixed	Mixed	Mixed	Mixed	Mixed	Mixed	Mixed	Mixed	Mixed	Mixed
06W03	Mixed	Down	Down	Down	Mixed	Down	Down	Mixed	Mixed	Mixed	Mixed	Mixed	Mixed
06W04	Down	Mixed	Mixed	Down	Down	Down	Down	Down	Down	Mixed	Mixed	Down	Down
07W01	Unch'd	Unch'd	Unch'd	Unch'd	Unch'd	Unch'd	Unch'd	Unch'd	Unch'd	Unch'd	Unch'd	Unch'd	Unch'd
07W02	Mixed	Down	Down	Down	Mixed	Down	Down	Mixed	Mixed	Mixed	Down	Down	Mixed
07W03	Mixed	Down	Down	Down	Mixed	Down	Down	Mixed	Mixed	Mixed	Down	Down	Mixed
07W04	Down	Mixed	Mixed	Mixed	Down	Mixed	Mixed	Down	Down	Down	Mixed	Mixed	Down
08W01	Unch'd	Unch'd	Unch'd	Unch'd	Unch'd	Unch'd	Unch'd	Unch'd	Unch'd	Unch'd	Unch'd	Unch'd	Unch'd
08W02	Mixed	Down	Down	Down	Mixed	Down	Down	Mixed	Mixed	Mixed	Down	Down	Mixed
08W03	Mixed	Down	Down	Down	Mixed	Down	Down	Mixed	Mixed	Mixed	Down	Down	Mixed
08W04	Down	Mixed	Mixed	Mixed	Down	Mixed	Mixed	Down	Down	Down	Mixed	Mixed	Down

3.6 Peak Load Factor Trend Analysis

The final set of information to be considered in the analysis is to assess the impact Smoothing has on the Peak Load Factors.

Each pair of charts below show the Single Year Peak Load Factors and the Smoothed Peak Load Factors for the last 4 years for the main EUC Bands.

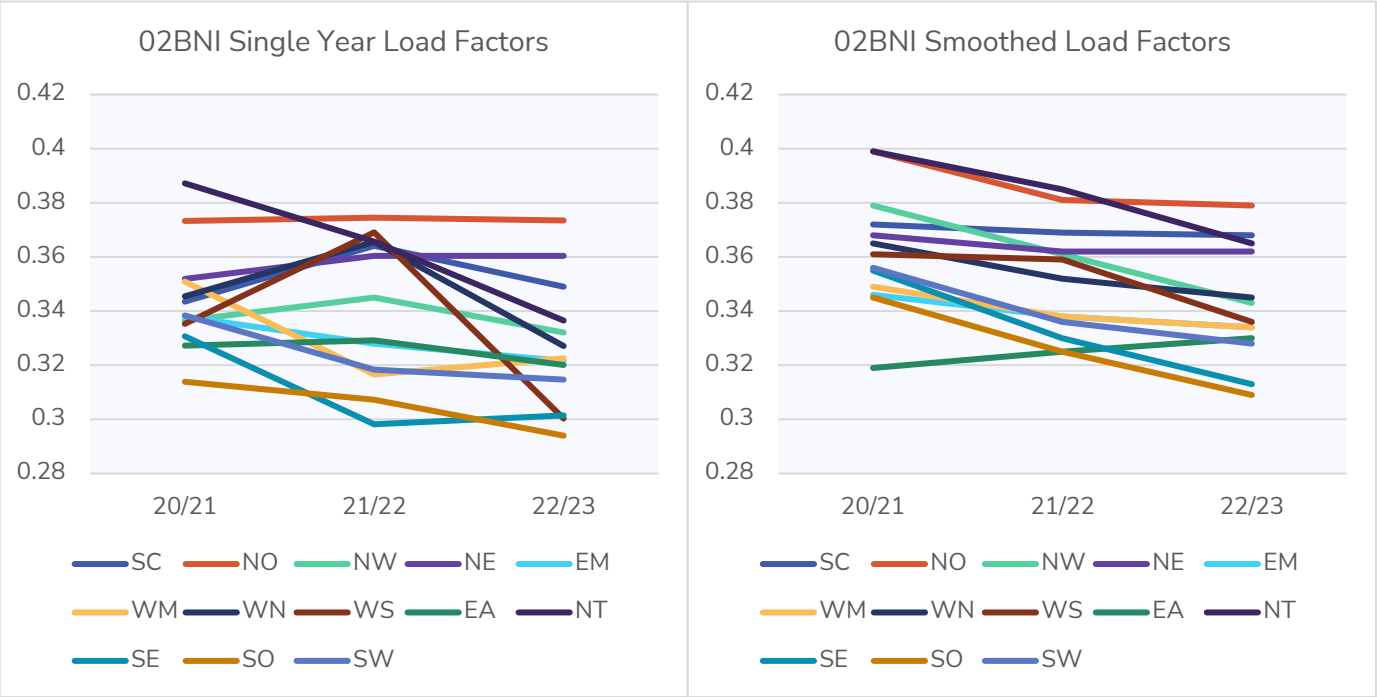
Figure 13. 01BND Peak Load Factors



Two LDZs are showing a Trend over the past 3 years (NE and WM, both down on the previous year) there is no clear Trend in the single year values for the other LDZs and the smoothed factors are much less volatile. For the two LDZs showing a Trend, the movement for the previous year (19/20 to 20/21) was against the Trend.

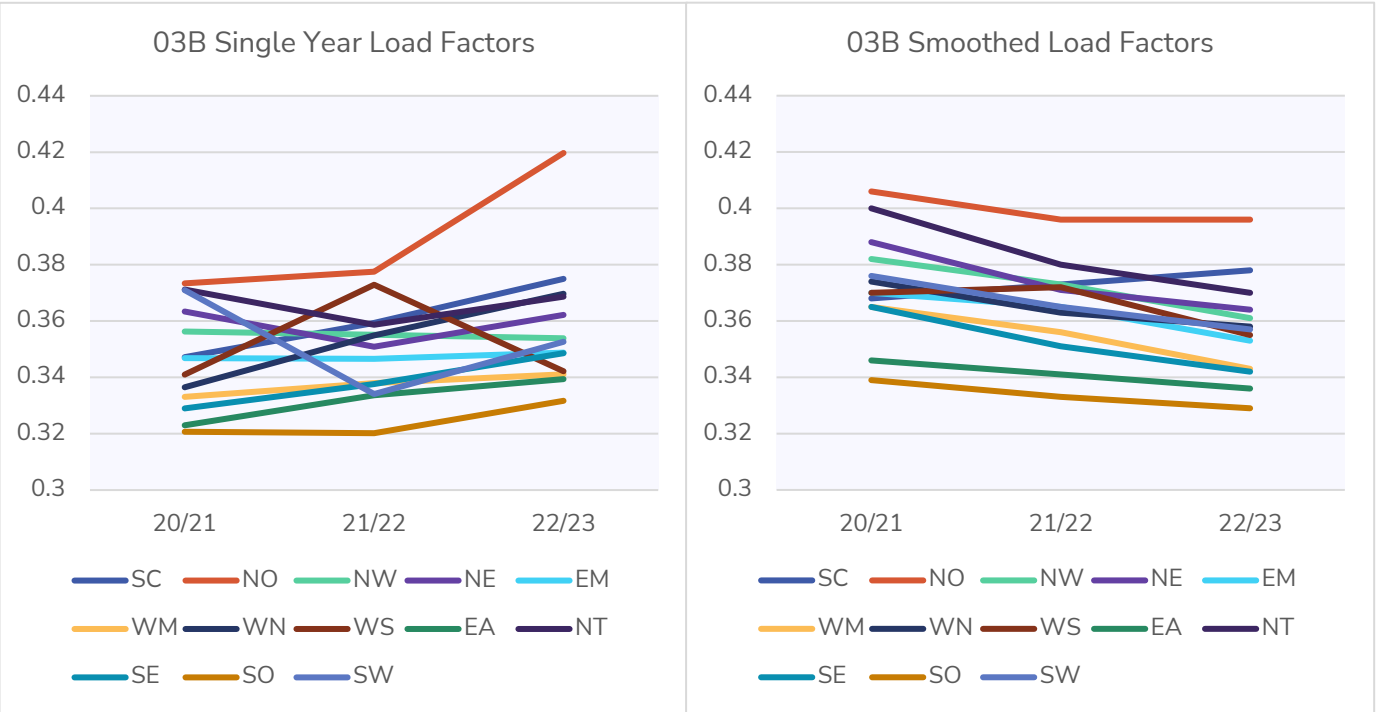
For all other EUCs (covered below), models were not re-run for 20/21 due to the impact of Covid 19 on the sample, therefore only the last 3 years are included in the charts (as 20/21 values are almost identical to 19/20).

Figure 14. 02BNI Peak Load Factors



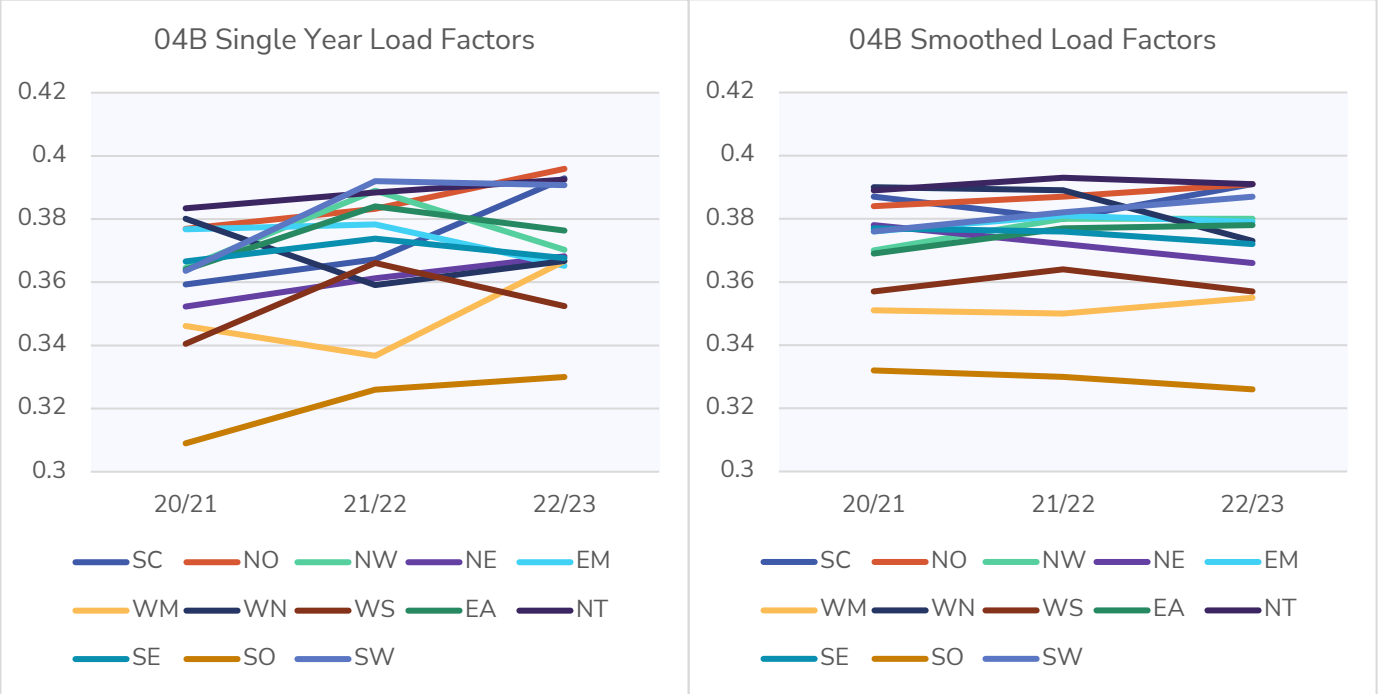
4 LDZs (EM, NT, SO and SW) are showing a Trend in the single year values (all down on the previous year), with the rest of the results mixed, and some particularly volatile year-on-year for single year models. There is no clear Trend across all LDZs.

Figure 15. 03B Peak Load Factors



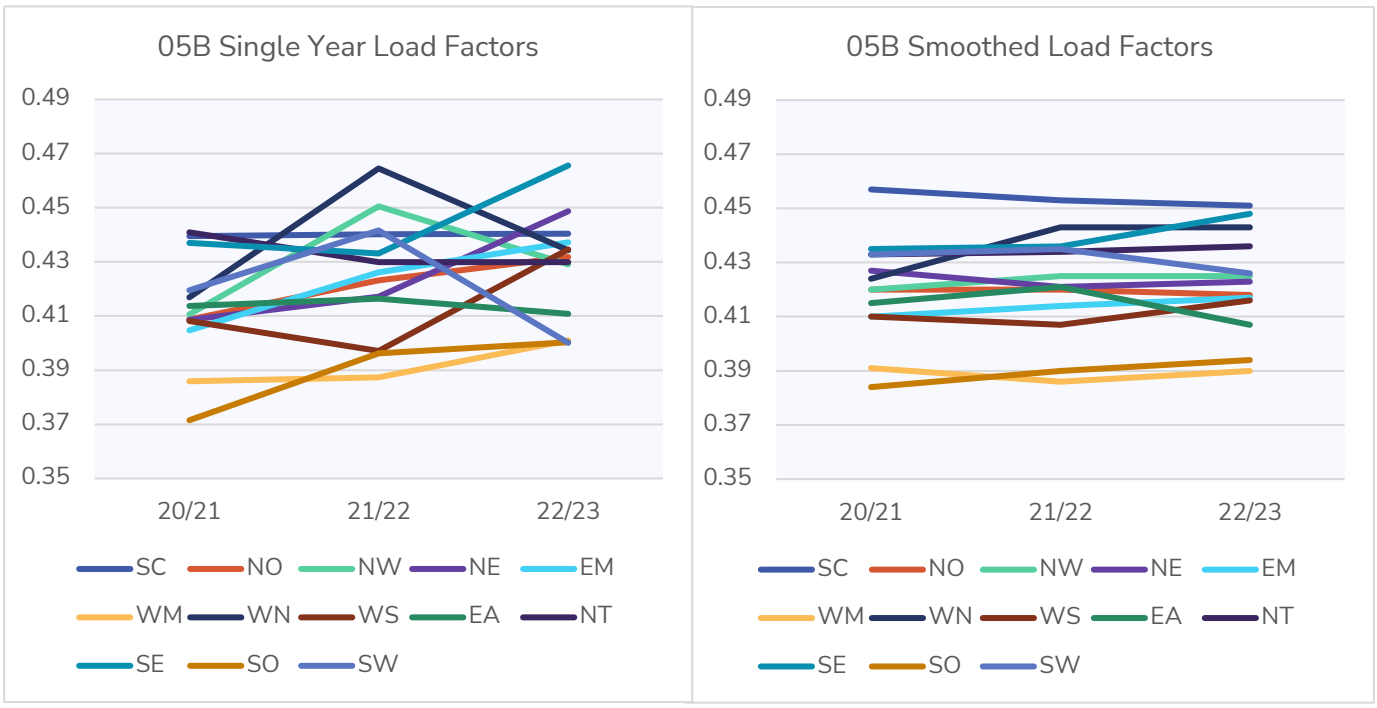
7 LDZs are showing a Trend, 6 upwards (SC, NO, WM, WN, EA and SE) and 1 downwards (NW), NO is showing the largest year on year movements. There is no clear Trend across all LDZs.

Figure 16. 04B Peak Load Factors



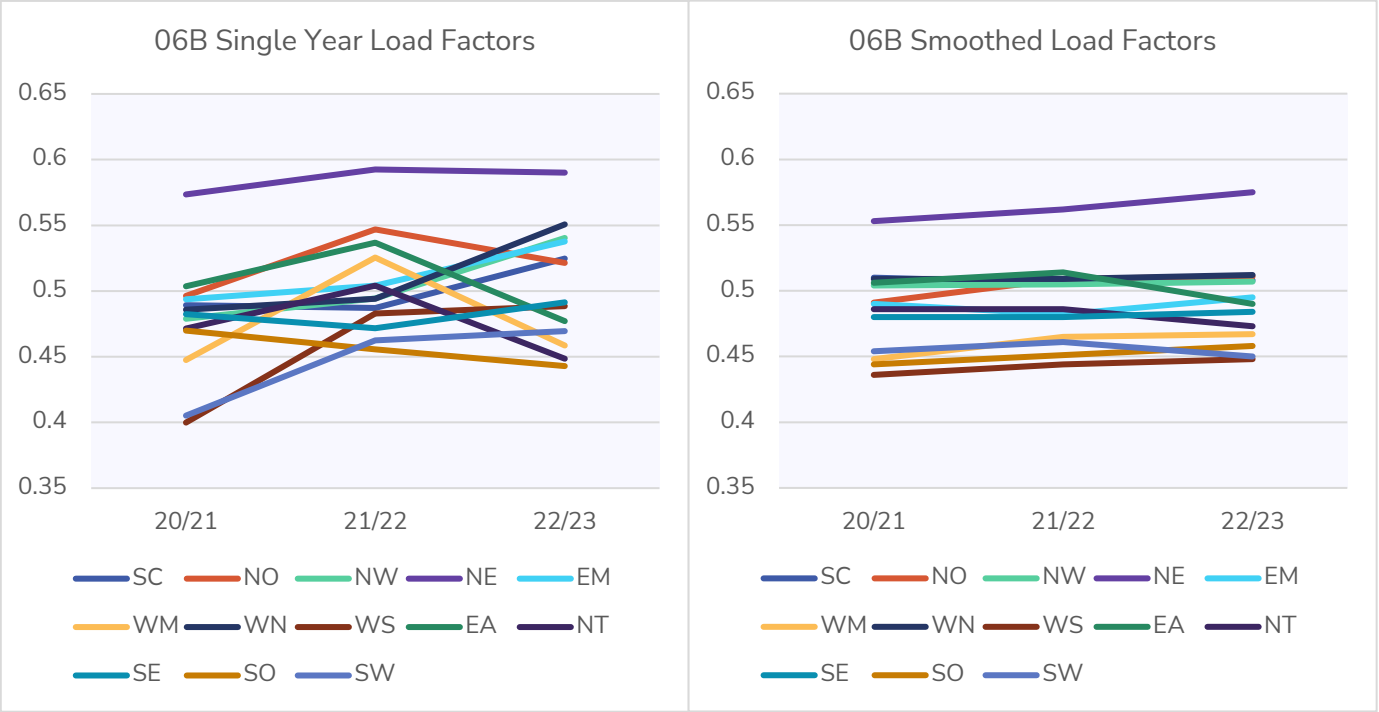
5 LDZs are showing a Trend over the 3 years (SC, NO, NE, NT and SO - all increasing year-on year), with the others showing mixed year-on-year movements. There is no clear Trend across all LDZs.

Figure 17. 05B Peak Load Factors



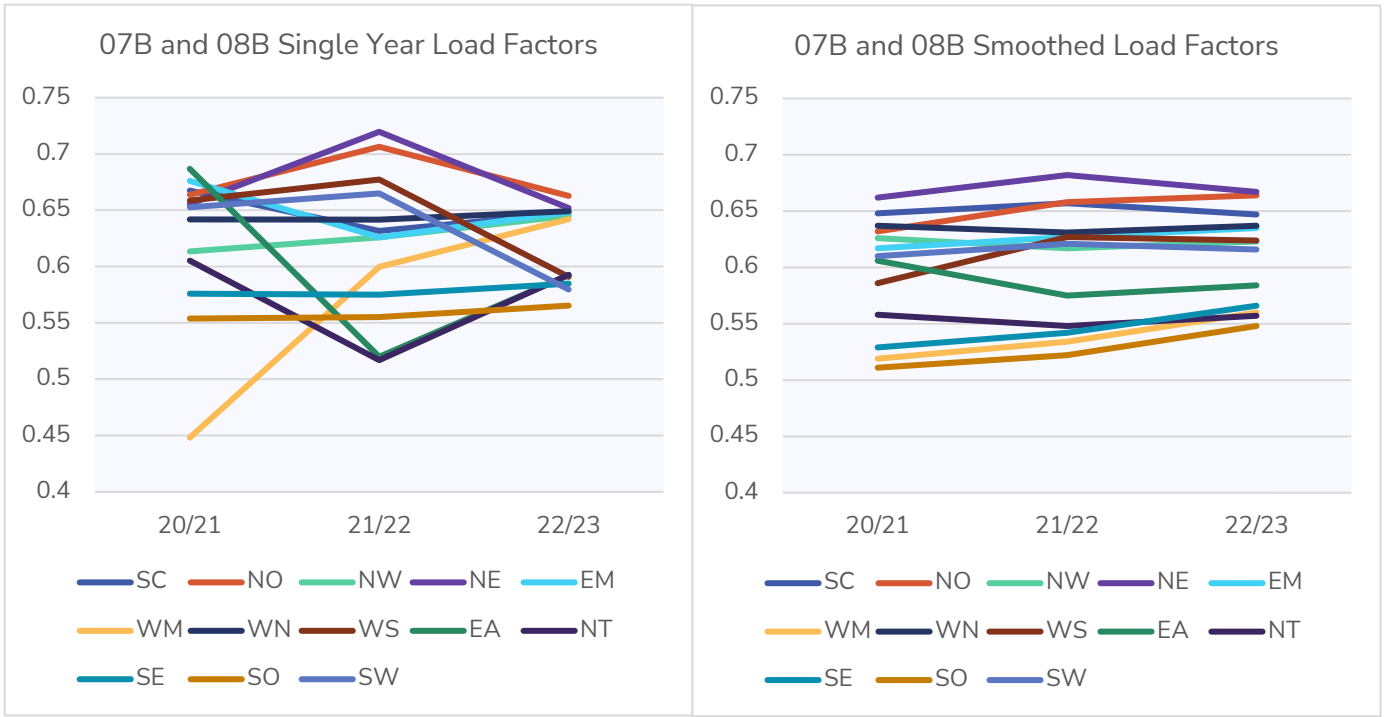
6 LDZs show a Trend in the year-on-year single year load factors (SC, NO, NE, EM, WM, WN, and SO – all trending upwards), with the rest mixed. There is no clear Trend across all LDZs, and some single year movements are significant.

Figure 18. 06B Peak Load Factors



5 LDZ are showing an upward Trend (NW, EM, WN, WS and SW) and 1 a downward Trend (SO) the rest are mixed. Some significant Volatility year-on-year which is mitigated in the smoothed models.

Figure 19. 07B and 08B Peak Load Factors



EUCs 07B and 08B are combined for modelling purposes, and therefore have the same Load Factors. 3 LDZs (NW, WM and SW) are showing a year-on-year Trend, all upwards, with the rest mixed. There are some significant year-on-year movements.

4. Conclusion

Based on these and previous results, the current 3-year model smoothing is deemed to be appropriate and fit for purpose due to:

- clear reduction of year-on-year Volatility
- no degradation in model Predictability
- no evidence of Trends being missed

The recommendation of the Demand Estimation team of the CDSP is to continue with the current model smoothing methodology.