DESC
Model Smoothing Evaluation

8th October 2018

Overview: Demand Estimation

- Key industry processes require various types of gas demand estimation at NDM Supply Points. These processes include:
  - Determining Supply Point Capacity
  - Daily Nominations and Allocations i.e. NDM Supply Meter Point Demand Formula
  - Determining Annual Quantities (AQs)
- To achieve this estimation, each NDM Supply Point belongs to an End User Category (EUC)
- EUCs are used to categorise NDM Supply Points in an LDZ and are defined by reference to variables which are maintained in the Supply Point Register
- Each EUC requires an associated Demand Model which represents its gas usage characteristics e.g. weather sensitivity, consumption profile etc
- Demand Models are mathematical models which provides an estimate of gas demand for each EUC by reference to variables determined by DESC

Overview: Demand Estimation

- For each Gas Year, DESC will develop or revise the definitions of the EUCs for the LDZ and the Demand Models for each EUC. The CDSP will then implement these decisions
- The annual process for determining the EUCs and Demand Models for the following gas year begins with the production of a document called the “Spring Approach”
- The Spring Approach provides an overview of the proposed EUC definitions and how the modelling shall be performed, including a reference to the sample data required in order to produce the relevant demand models
- DESC approved the latest version of the Spring Approach after its meeting in February, which included the possibility of deriving additional EUCs in Bands 1 and 2
- Section H of UNC and the NDM Demand Estimation Methodology document provides more detail of the Demand Estimation process

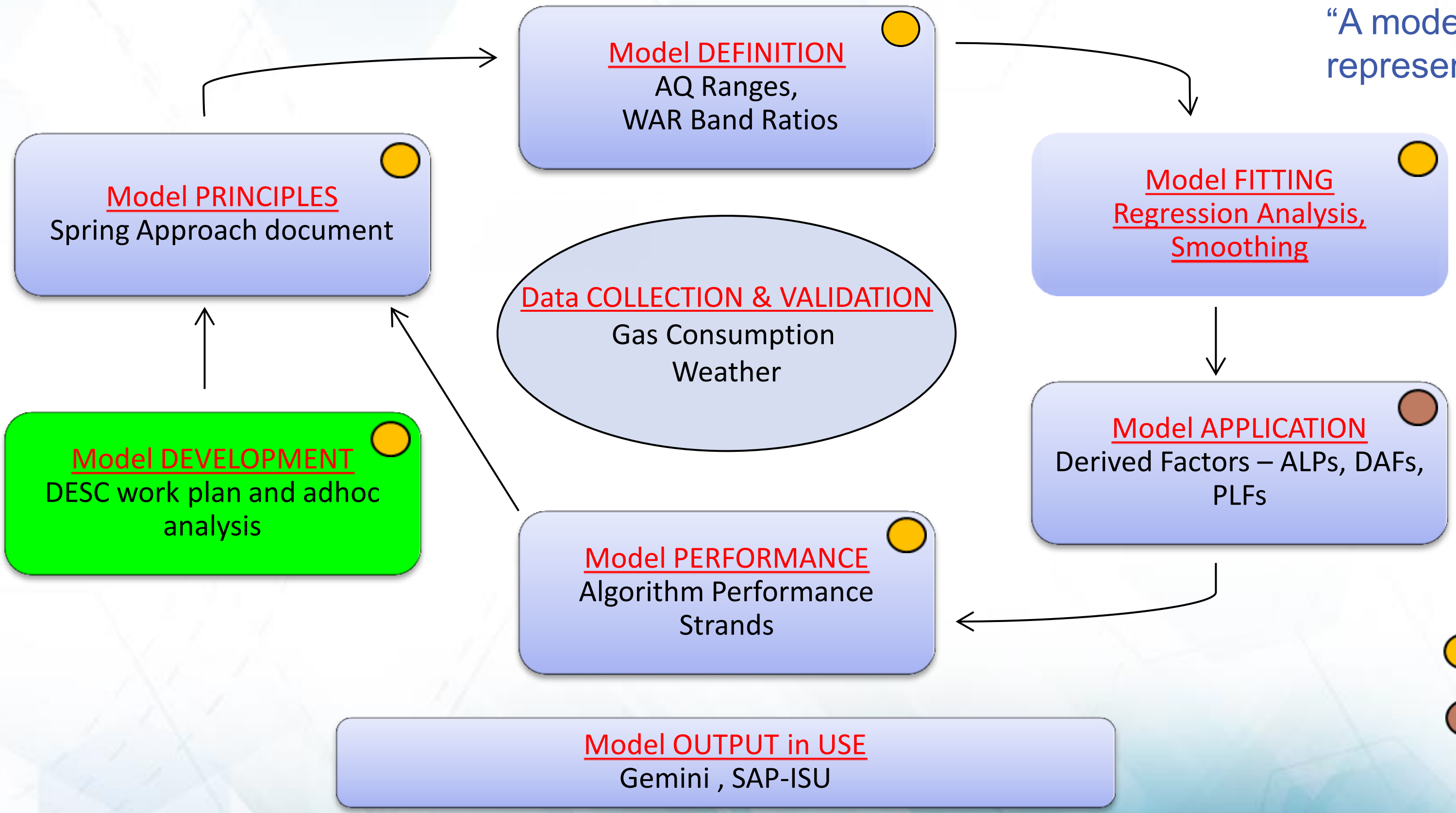
Overview: Demand Modelling Framework

- DESC's obligation of producing a set of End User Categories and Demand Models for the next gas year has to be delivered within certain timescales:
  - The sample data collected for analysis must include the most recent Winter period (December to March), meaning the sample data collation and validation cannot start until early April
  - The Final EUCs and Demand Models must be approved and submitted to the Authority and loaded to CDSP's systems by 15th August
  - In between April and August is when the sample data validation results are reviewed, WAR Band ratios are set, single year models are developed and reviewed, model smoothing is applied, draft Derived Factors are produced and reviewed, followed by an industry consultation commencing early June
- The above explains why it is necessary to agree modelling principles and methodologies in February each year, as there is not time in the Spring/Summer to make fundamental modelling decisions and gain agreement from all DESC members

Overview: EUC & Demand Model Lifecycle

The purpose of the EUC Demand Model is to represent the behaviour and reactions of the EUC Population

“A model is a simplified representation of reality”



DESC / TWG Checkpoint

Industry Consultation

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Overview: Demand Estimation Timetable - 2018

High Level View of Demand Estimation Timetable 2018 - Key Checkpoints

PHASE	JAN'18	FEB'18	MAR'18	APR'18	MAY'18	JUN'18	JUL'18	AUG'18	SEP'18	OCT'18	NOV'18	DEC'18
1. MODEL PRINCIPLES												
Spring Approach 2018 Approved (DESC)		13th Feb										
2. Data COLLECTION & VALIDATION												
Sample data validated (CDSP)				13th Apr								
3. MODEL DEFINITION												
Agree Data Aggregations / WAR Band Limits (TWG)				24th Apr								
4. MODEL FITTING												
Small & Large NDM Single Year modelling review (TWG)					15th May							
5. MODEL APPLICATION												
Publication of Draft Derived Factors (CDSP)						1st June						
Derived Factors Approved for wider industry (TWG/DESC)							9th July					
Final Approval of Derived Factors (DESC)							24th July					
6. MODEL OUTPUT IN USE												
SAP-ISU and Gemini updated (CDSP)								15th Aug				
7. MODEL DEVELOPMENT												
Adhoc Work-plan approved (DESC)							24th July					
8. MODEL PERFORMANCE												
Strands 1 to 4 reviewed (DESC)												TBC

Objective

- To assess whether model smoothing approach continues to reduce volatility in models from one year to the next

Background

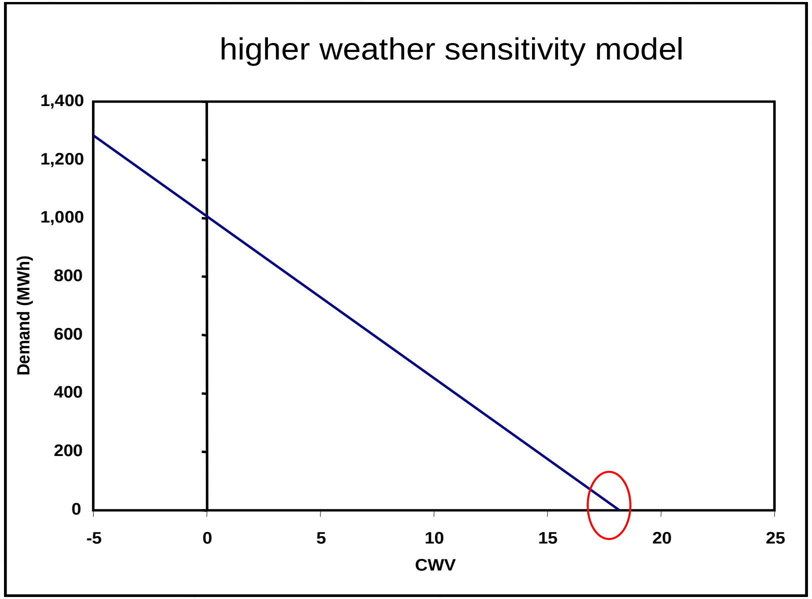
- Model smoothing was first undertaken in 1999/00 and has been applied to all subsequent years based on the methodology detailed in Spring Approach document
- In January 2006, DESC agreed to move to a biennial assessment of the continued applicability of model smoothing
- The analysis presented today is the first full assessment of model smoothing since Autumn 2015 and has been carried out along the same lines
- The following presentation summarises the results and conclusions, however there is a supporting document also available which provides further detailed commentary and analysis – document name: DESC_Model Smoothing Review_Autumn18.pdf

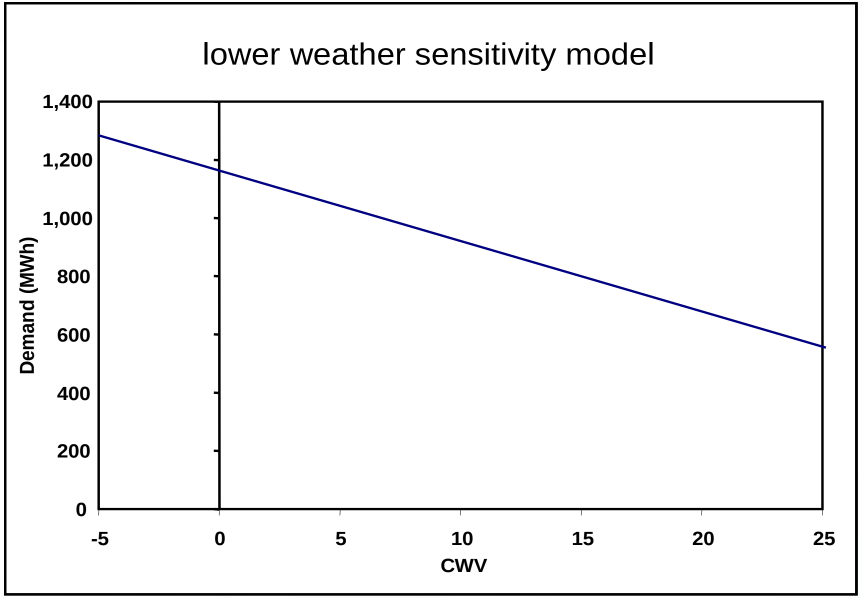
Model Smoothing: Principles

- Model smoothing is the averaging of 3 years of models (including the current and most recent data sets) to derive new parameters
- Introduced to address year on year volatility and provide more stability in EUC models
- Model smoothing will not necessarily improve model predictability, however it may be better than single year models
- Analysis performed considers i) volatility, ii) predictability and iii) trend analysis
- Model smoothing assessments are undertaken using the CWV intercept differences from the relevant single year or smoothed models

Model Smoothing: CWV Intercepts

- Section 6 of annual NDM report contains individual year and smoothed model CWV intercepts





Model Smoothing: Assessment of Volatility

Single Year Data Sets

Smoothed Model (Sm)

2015/16 (Yr.1)
2016/17 (Yr.2)
2017/18 (Yr.3)

for Gas Year 2018/19 (Sm)

Most recent data set available is 2017/18

2014/15 (Yr.1)
2015/16 (Yr.2)
2016/17 (Yr.3)

for Gas Year 2017/18 (Sm)

Single Year Test

Examines **2017/18 (Yr.3)** against **2016/17 (Yr.2)** indicating extent of year on year change

Smoothed Model Test

Examines **2018/19 (Sm)** against **2017/18 (Sm)** indicating extent of year on year change

Tests

- The following explains the tests used to complete the review of model smoothing:

- Observe the differences between intercepts visually by comparing the spread of the data using bin range

- Root Mean Squared (RMS): This is used to give the average value of the magnitude of differences in intercepts. i.e. if we just used the straight average for:

  Single Year Models = (2, -2, 2, -2) and

  Smoothed Models = (1, -1, 1, -1)

  the average for both is 0, even though the single model values are twice as big as the smoothed model values.

- The RMS allows us to appreciate that on average, the differences in intercepts for the single year models are twice as big as the smoothed models

Analysis

- Aim:
  To assess the level of year on year volatility of each model type (smoothed and single year) by comparing the differences between each year. This is achieved by using variations in the CWV intercepts and calculating the overall RMS values

- Analysis:

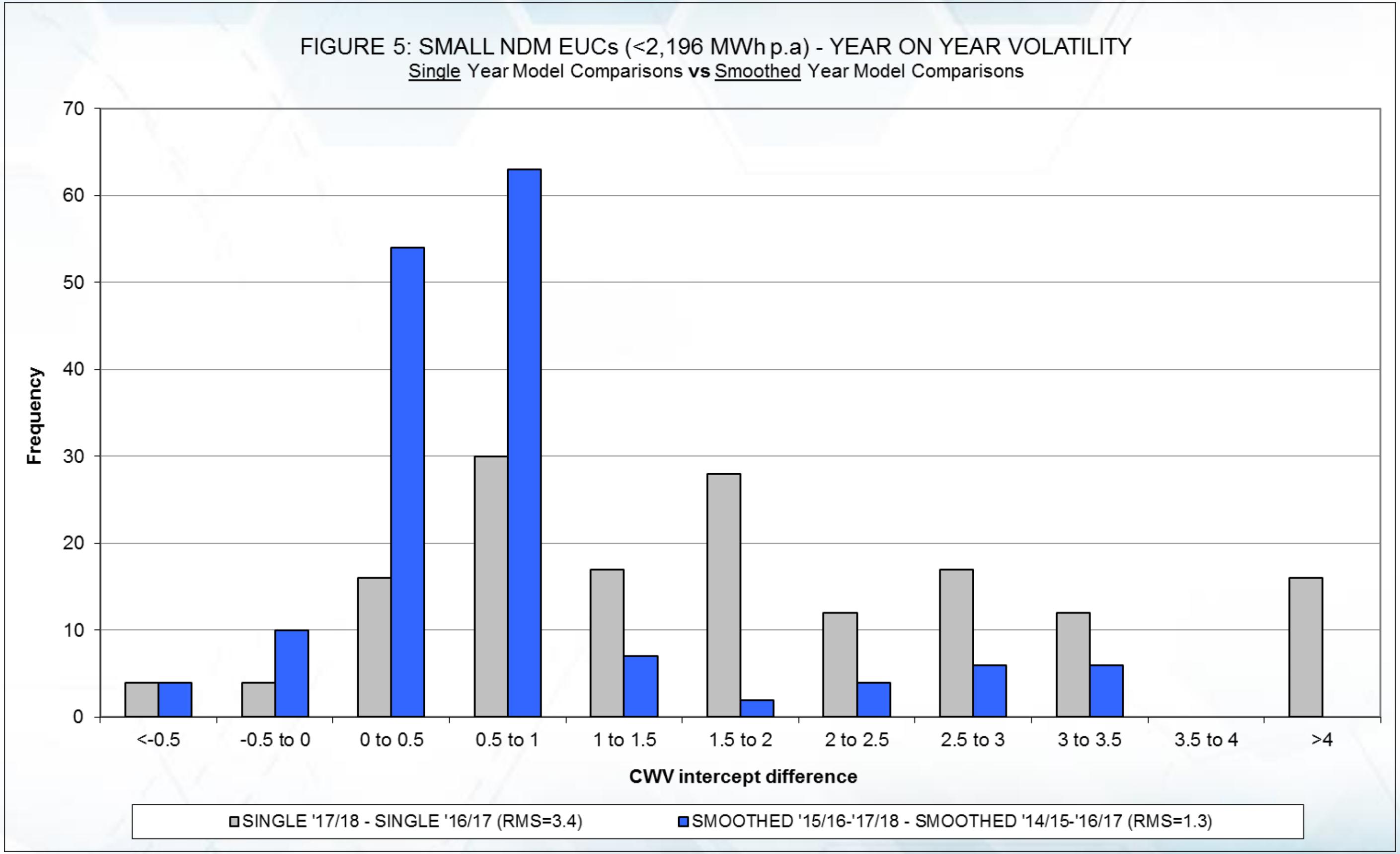
  - Smoothed Year Model comparisons

    Applicable Smoothed model for ‘18/19 (*based on ‘15/16, ‘16/17, ‘17/18*) compared to the applied Smoothed model for ‘17/18 (*based on ‘14/15, ‘15/16, ‘16/17*)

  - Single Year Model comparisons

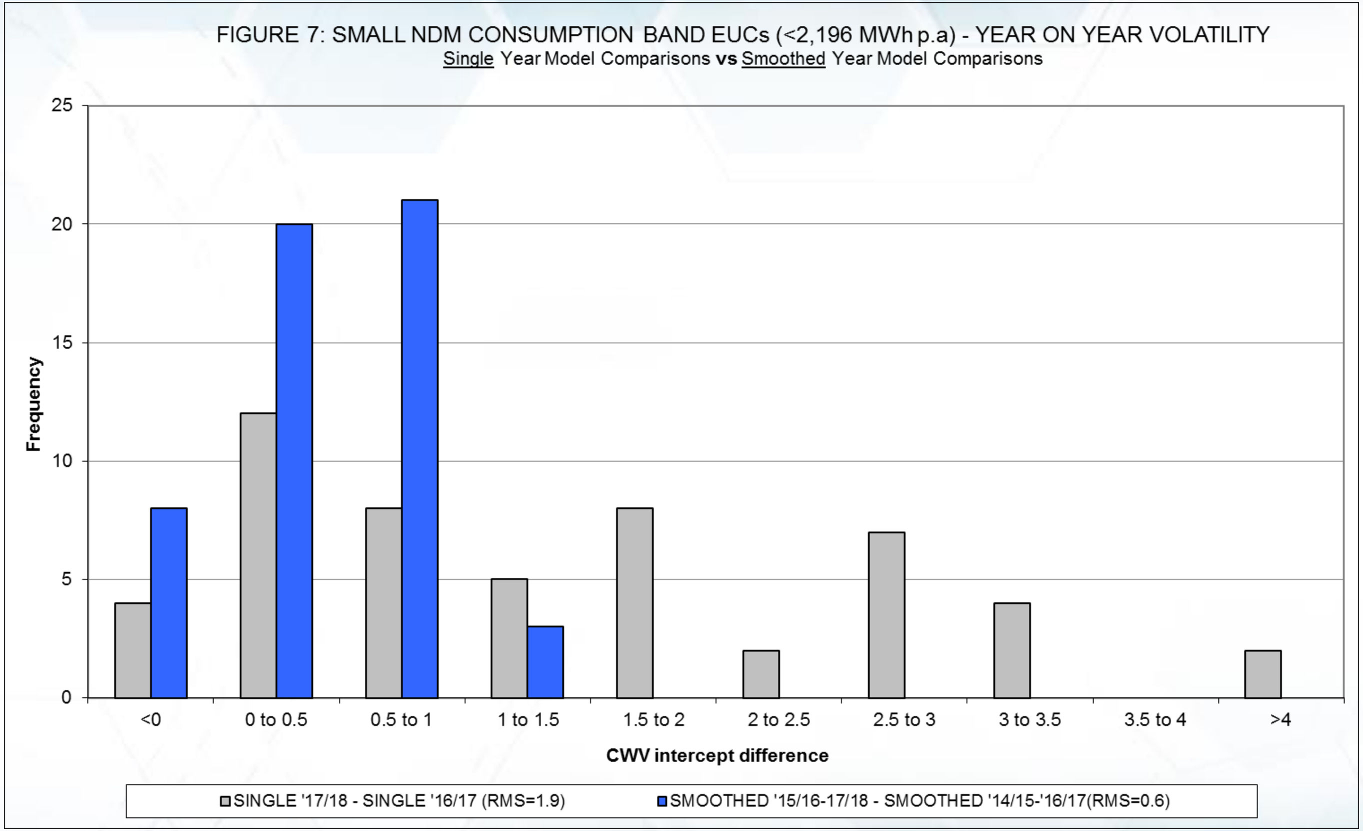
    Single year model for ‘17/18 (*that would have been applied to ‘18/19*) compared to the Single year model for ‘16/17 (*that would have been applied to ‘17/18*)

Volatility Analysis: Small NDM – All EUC Bands



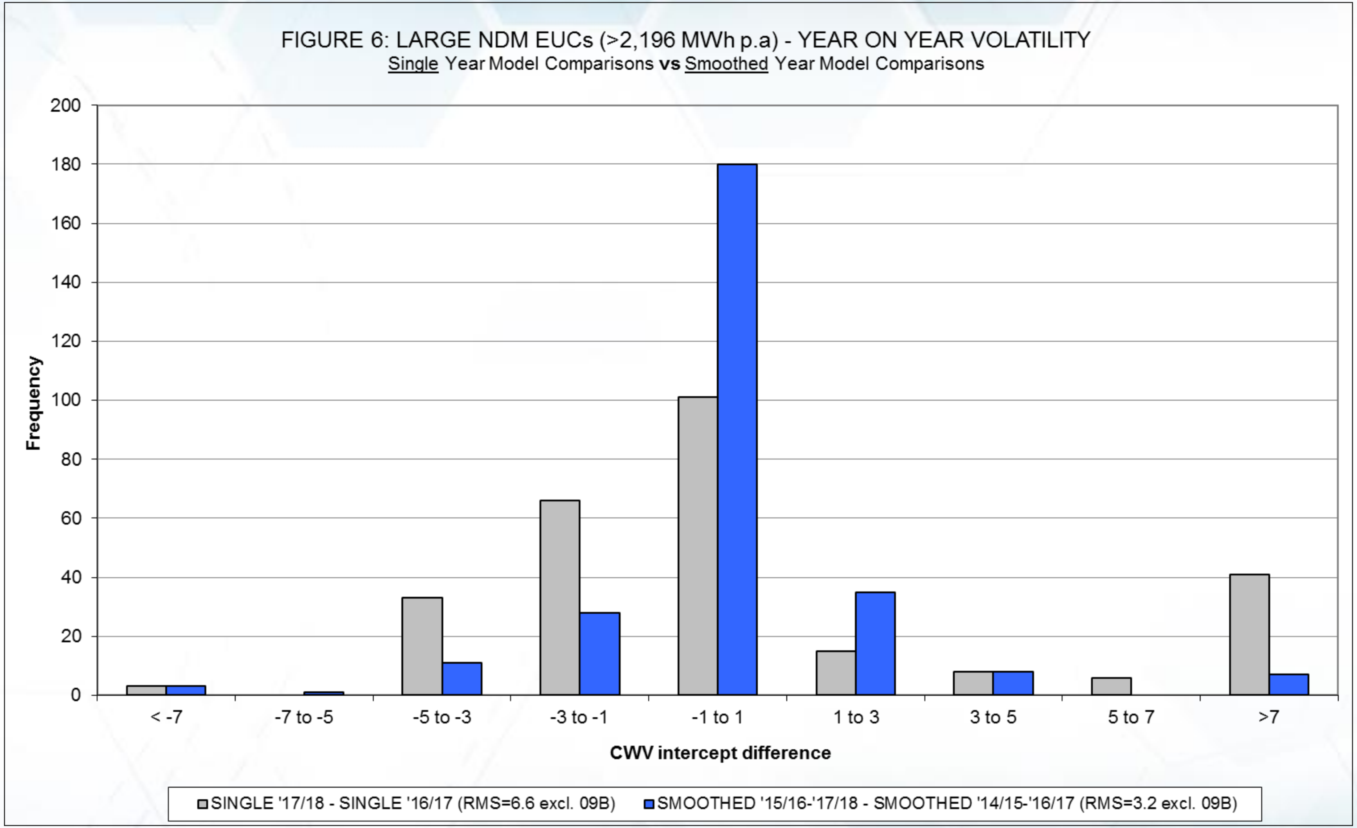
- 156 Small NDM EUCs assessed
- Smoothed Model clearly has smaller CWV intercept differences and lower RMS (**1.3 vs 3.4**) values and so overall less volatility

Volatility Analysis: Small NDM – Consumption Bands



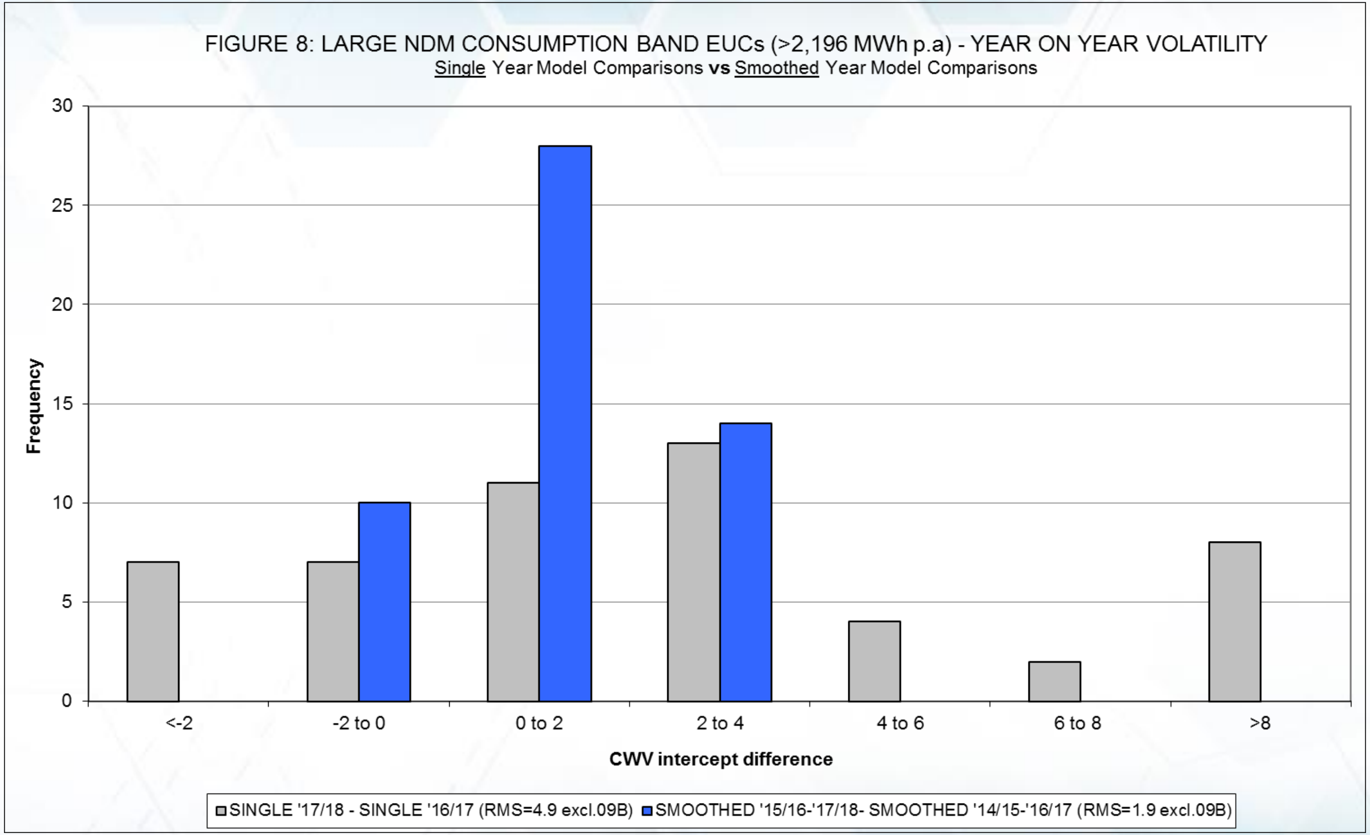
- 52 Small NDM Consumption bands assessed
- Smoothed Model clearly has smaller CWV intercept differences and lower RMS (**1.9 vs 0.6**) values and so overall less volatility

Volatility Analysis: Large NDM – All EUC Bands



- 273 Large NDM EUCs assessed
- Smoothed Model clearly has smaller CWV intercept differences and lower RMS (**6.6 vs 3.2**) values and so overall less volatility

Volatility Analysis: Large NDM – Consumption Bands



- 52 Large NDM Consumption bands assessed
- Smoothed Model clearly has smaller CWV intercept differences and lower RMS (**4.9 vs 1.9**) values and so overall less volatility

Model Smoothing Results 1: Volatility Assessment

- Analysis shows that the smoothed models for Large and Small NDM EUCs are associated with significantly lower year on year volatility as shown by:
  - Generally narrower distribution of CWV intercepts differences
  - Generally notable smaller values in the corresponding RMS Values
- Further analysis carried out to assess predictive ability…

Model Smoothing: Assessment of Predictability

Single Year Data Sets | Smoothed Model (Sm)

2015/16 (Yr.1)
2016/17 (Yr.2)
2017/18 (Yr.3)

for Gas Year 2018/19 (Sm)

2014/15 (Yr.1)
2015/16 (Yr.2)
2016/17 (Yr.3)

for Gas Year 2017/18 (Sm)

Most recent data set available is 2017/18

Single Year Test
Examines **2017/18 (Yr.3)** against **2016/17 (Yr.2)** indicating year on year change

Smoothed Model Test
Examines **2017/18 (Yr.3)** against **2017/18 (Sm)** indicating year on year change

Analysis

- Aim: To assess the predictive ability of each model type (smoothed and single year) by comparing the difference of the actual CWV intercept from the most recent data set (i.e. 2017/18) to the single year model and the smoothed model. This is achieved by using variations in the CWV intercepts and calculating the overall RMS values

- Analysis:

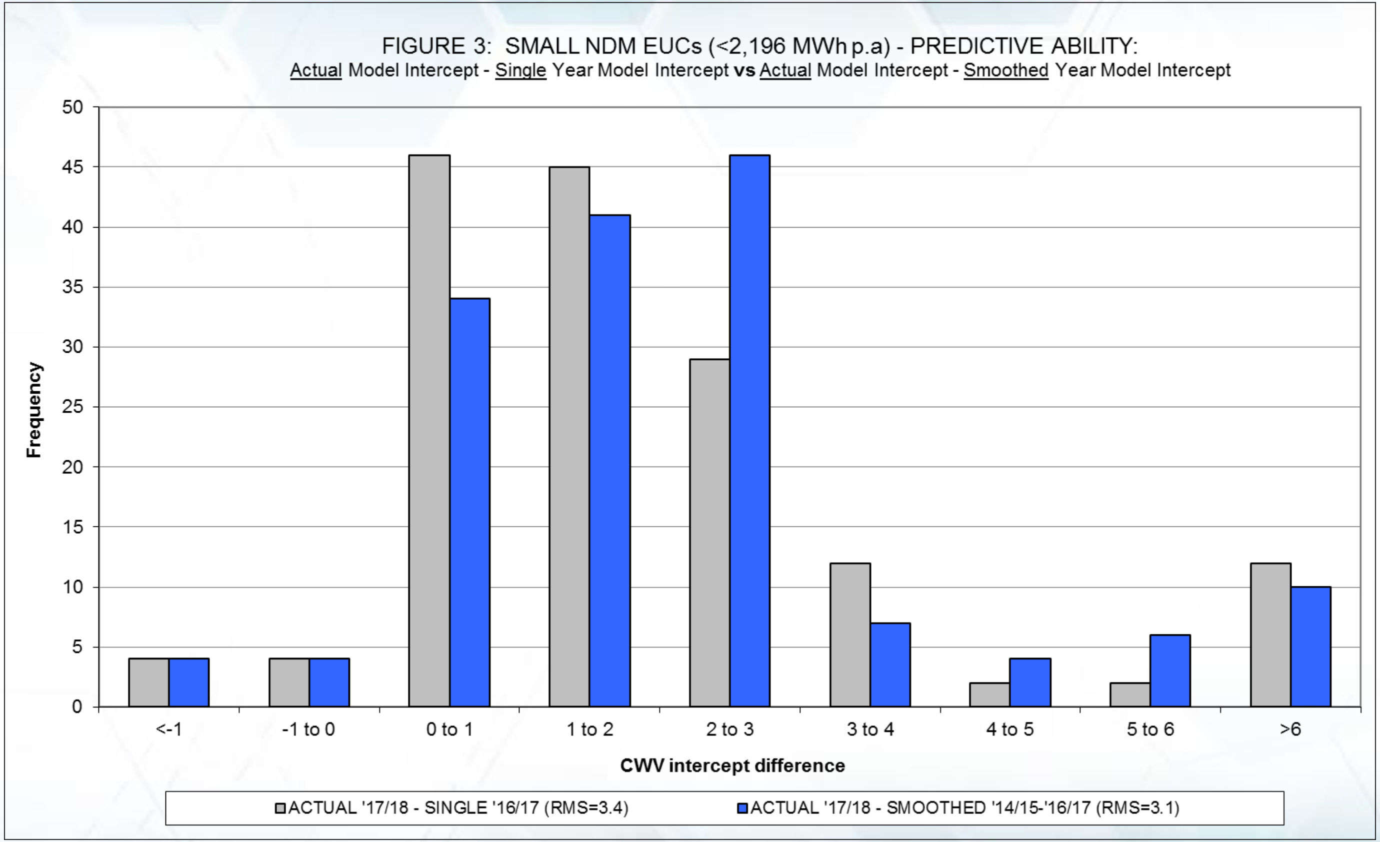
  - Smoothed Year Model comparisons

    Applicable Smoothed model for ‘17/18 (*based on ‘14/15, ‘15/16, ‘16/17*) compared to the most recent dataset for ‘17/18

  - Single Year Model comparisons

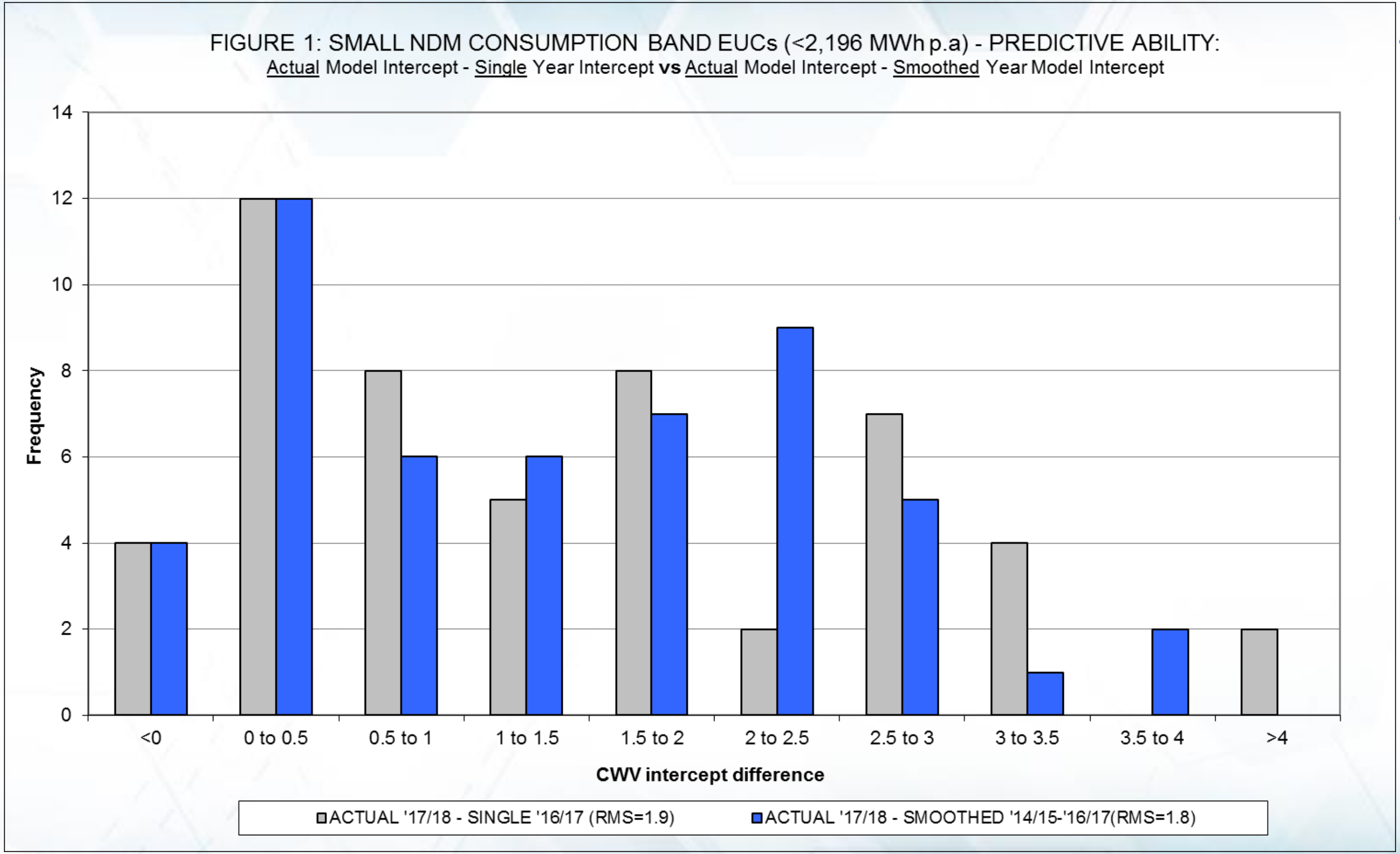
    Single year model for ‘17/18 (*that would have been applied to ‘18/19*) compared to the most recent dataset for ‘16/17

Predictive Ability: Small NDM – All EUC Bands



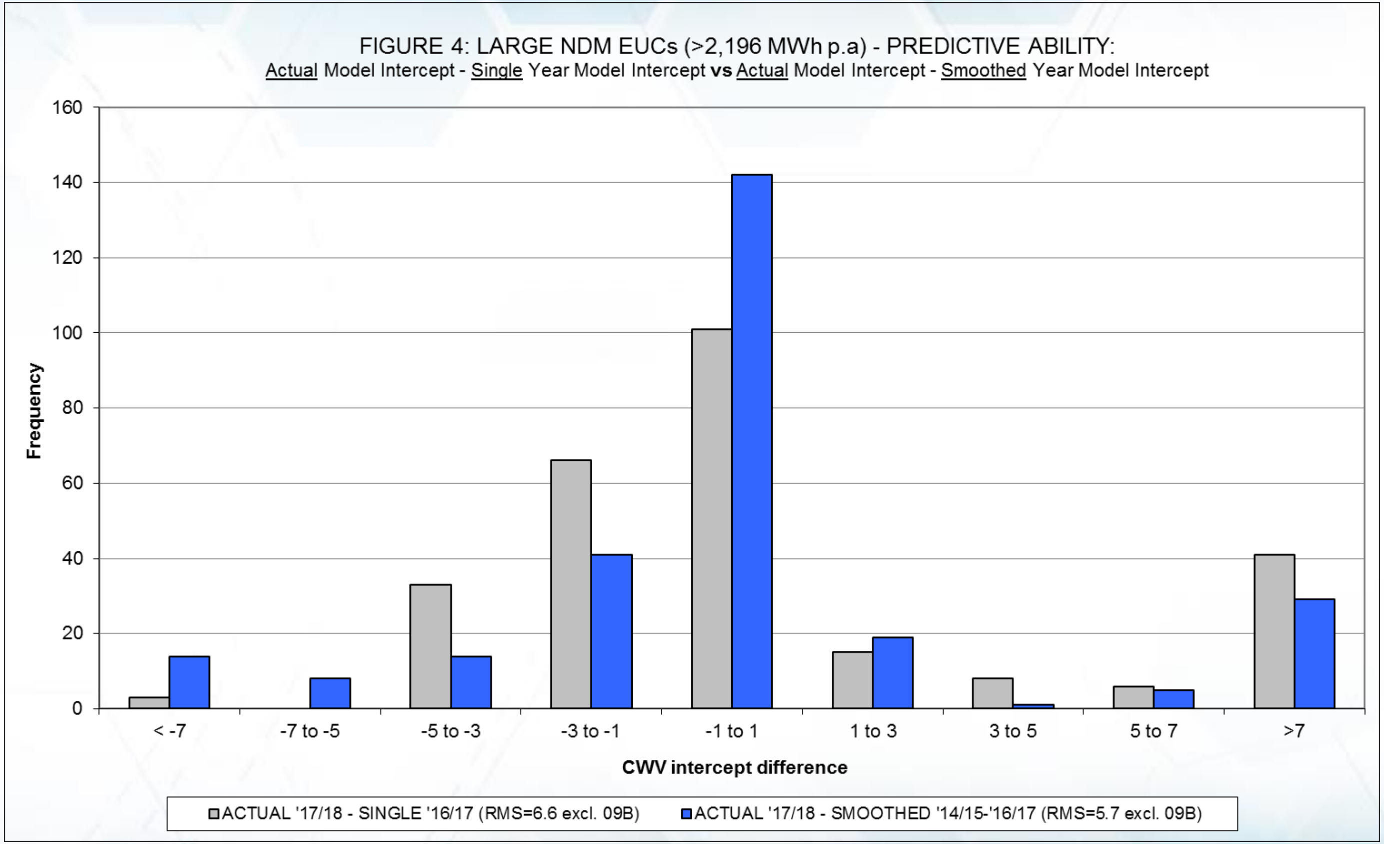
- 156 Small NDM EUCs assessed
- Smoothed model and single year models have a similar spread of CWV intercept differences. Smoothed model has a slightly lower RMS (**3.4 vs 3.1**)

Predictive Ability: Small NDM – Consumption Bands



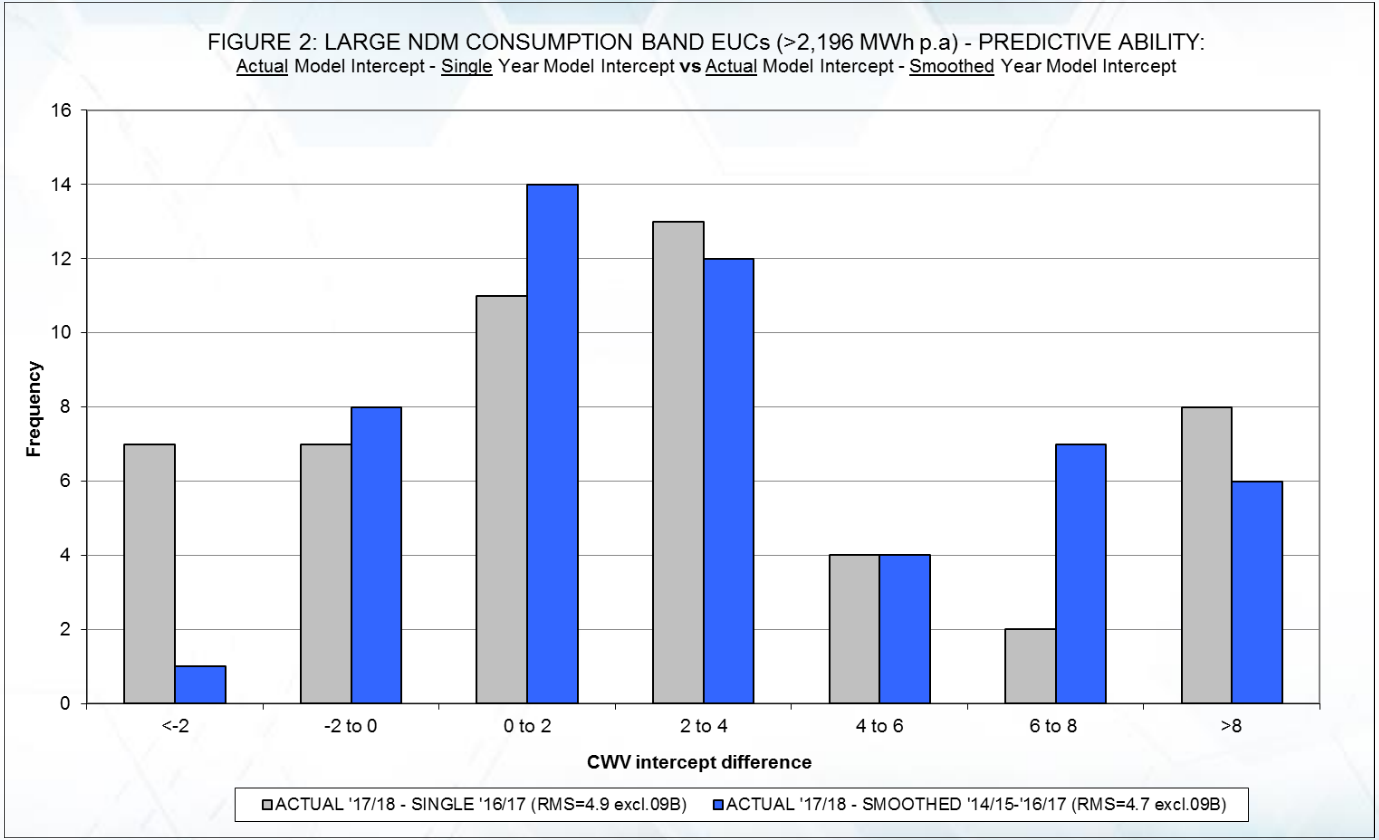
- 52 Small NDM Consumption bands assessed
- Smoothed model and single year models have a similar spread of CWV intercept differences. Smoothed model has a slightly lower RMS (**1.9 vs 1.8**)

Predictive Ability: Large NDM – All EUC Bands



- 273 Large NDM EUCs assessed
- Smoothed model and single year models have a similar spread of CWV intercept differences. Smoothed model has a slightly lower RMS (**5.7 vs 6.6**)

Predictive Ability: Large NDM – Consumption Bands



- 52 Large NDM Consumption bands assessed
- Smoothed model and single year models have a similar spread of CWV intercept differences. Smoothed model has a slightly lower RMS (**4.9 vs 4.7**)

Model Smoothing Results 2: Predictive Ability

- For Small NDM whether analysing all EUCs or the consumption band EUCs the smoothed model for 2017/18 showed a similar spread of CWV intercept differences, compared to the single year model, which is also reflected in the respective RMS values which are only slightly lower for the smoothed year model

- For Large NDM the conclusion is also similar to the small NDM EUCs and consumption bands. The spread between the two data sets are similar, but the majority of the intercept differences for the smoothed model in the EUC bands tend to be smaller in comparison to the single year models. When assessing all EUCs and consumption bands the smoothed model for 2017/18 shows a slightly better performance, which is reflected in the RMS values.

- Overall, there is no strong evidence that either smoothed models or single year models are consistently better in terms of predictive ability

- The main driver for using a smoothed model is the mitigation of year of year volatility rather than predictive ability.

Model Smoothing Results: CWV Intercept Trends (3yr)

- Aim: To identify any trends occurring in CWV intercepts between each year. This is achieved by comparing trends in the CWV intercept value for the 3 single year models constituting the 18/19 smoothed model.

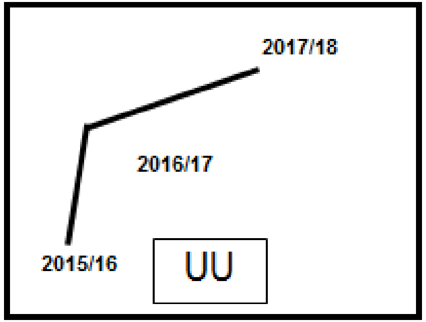
  Argument for single year models rather than smoothed could be strengthened if evidence of underlying trends

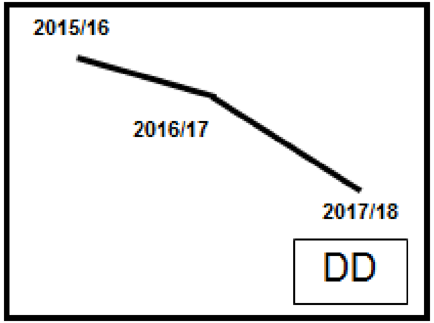
- Analysis:

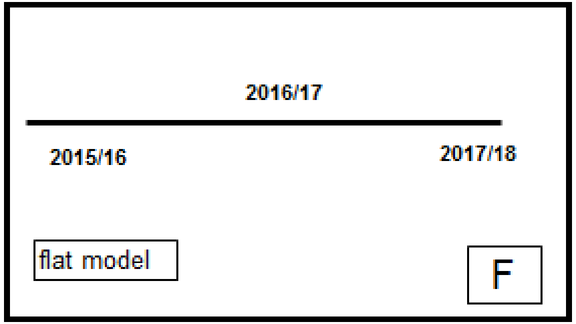
  - CWV intercepts for ‘15/16 single year models
  - CWV intercepts for ‘16/17 singe year models
  - CWV intercepts for ‘17/18 single year models

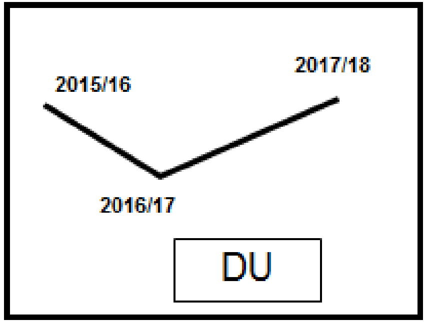
  - 5 possible outcomes when completing the analysis. Next slide summarises these….

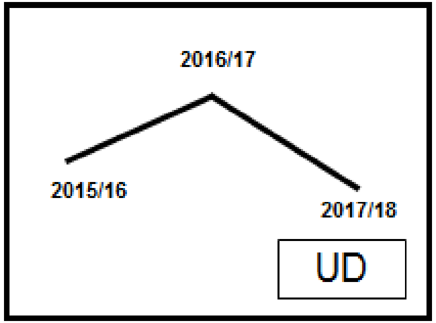
CWV Intercepts Trends: 3 year possible outcomes











CWV Intercept Trends: Results of Analysis – 3 years

EUC	Type					Total	
	UU	UD	DU	DD	F		
2015/16, 2016/17 and 2017/18 Analysis Years	168	56	160	3	42	429	Autumn 2018
2014/15, 2015/16 and 2016/17 Analysis Years	121	132	103	31	42	429	Autumn 2017
2013/14, 2014/15 and 2015/16 Analysis Years	78	96	160	57	38	429	Autumn 2016
2012/13, 2013/14 and 2014/15 Analysis Years	11	135	136	109	38	429	Autumn 2015
2011/12, 2012/13 and 2013/14 Analysis Years	75	194	68	58	34	429	Autumn 2014
2010/11, 2011/12 and 2012/13 Analysis Years	132	117	115	26	39	429	Autumn 2013
2009/10, 2010/11 and 2011/12 Analysis Years	135	150	74	31	39	429	Autumn 2012

- Table summarises the results for all EUCs for 3 year CWV intercept patterns
- Results highlighted are ‘new’ since last review of model smoothing in Autumn 2015
- Predominant effect is that of no consistent pattern (“UD” and “DU”) - 256 in ’16, 235 in ‘17 and 216 in ’18
- Rise seen in instances of a increasing pattern (“UU”) – from 11 in ’15 to 168 in ’18. Also a rise in the number of flat models since ‘14.
- For individual EUC and LDZ details see Table 2 in accompanying document

Model Smoothinhg Results 3: CWV Intercept Trends (4yr)

- Aim: To identify any trends occurring in CWV intercepts between each year. This is achieved by comparing trends in the CWV intercept value for the 4 single year models

- Analysis:

  - CWV intercepts for ‘14/15 single year models
  - CWV intercepts for ‘15/16 single year models
  - CWV intercepts for ‘16/17 singe year models
  - CWV intercepts for ‘17/18 single year models

- Analysis summarises possible outcomes as:

  - N: No consistent trend
  - D: Decreasing values
  - U: Increasing values
  - F: Flat or nearly flat models

CWV Intercept Trends: Results of Analysis – 4 years

EUC	Type				Total	
	N	D	U	F		
2014/15, 2015/16, 2016/17 and 2017/18 Analysis Years	297	1	90	41	429	Autumn 2018
2013/14, 2014/15, 2015/16 and 2016/17 Analysis Years	350	7	33	39	429	Autumn 2017
2012/13, 2013/14, 2014/15 and 2015/16 Analysis Years	378	13	0	38	429	Autumn 2016
2011/12, 2012/13, 2013/14 and 2014/15 Analysis Years	372	13	6	38	429	Autumn 2015
2010/11, 2011/12, 2012/13 and 2013/14 Analysis Years	346	14	35	34	429	Autumn 2014
2009/10, 2010/11, 2011/12 and 2012/13 Analysis Years	308	7	75	39	429	Autumn 2013
2008/09, 2009/10, 2010/11 and 2011/12 Analysis Years	335	16	39	39	429	Autumn 2012

- Table summarises the results for all EUCs for 4 year CWV intercept patterns
- Examined over 4 years the predominant effect is one of no consistent pattern across each LDZ and EUC band/WAR band
- Over 4 years 90 EUCs of 429 showed a consistently upward pattern which is a lot higher when compared to previous years
- For individual EUC and LDZ details see Table 3 in accompanying document

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Model Smoothing Results 4: Load Factor Trends

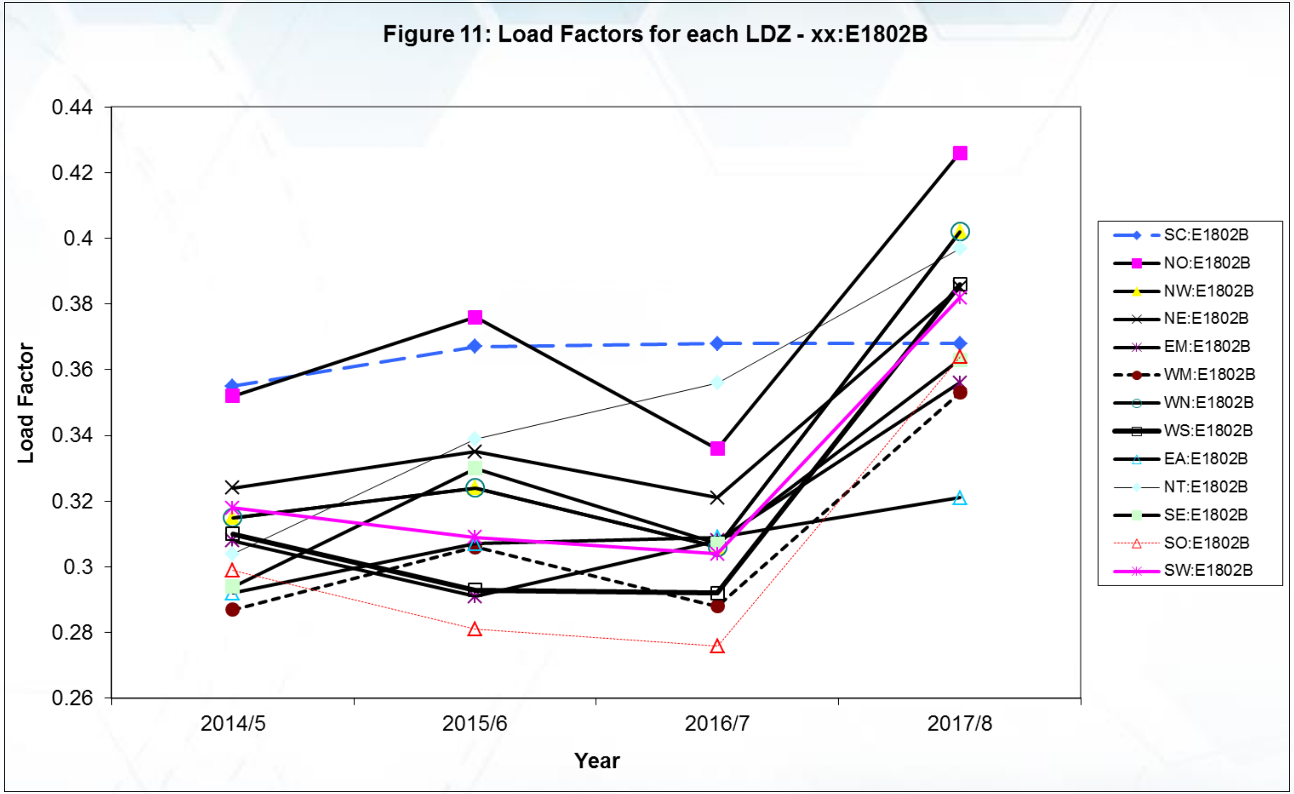
- Aim: To identify any trends occurring in the Load Factors for the individual years models

  This is achieved by comparing the Load Factor values for the 4 single year models (constituting the 18/19 smoothed model and the year prior to this) in graphical format

- Analysis:

  - Load Factors '14/15 based on single year model
  - Load Factors '15/16 based on single year model
  - Load Factors '16/17 based on single year model
  - Load Factors '17/18 based on single year model

Load Factor Trends: Results of Analysis – 4 years



- Graph shows the Load Factors for the single year models for 02B
- Examined over 4 years, generally the predominant effect is showing mixed movements for the first 3 years but the most recent year has shown a significant upward trend
- Over 4 years 22 of 117 Consumption Band EUCs showed an upward trend in each of the 4 years. There were 0 that showed a downward trend for all of the 4 years.
- Figures 10-18 in accompanying document provide values for all Consumption Band EUCs

Model Smoothing Review: Conclusions

- Principles of model smoothing:
  - Reduce year on year volatility
  - Not necessarily to improve model prediction
  - Necessary to review and assess if emerging trends are identified
- Current analysis consistent with results from previous analysis
  - Model smoothing does reduce year on year volatility overall
  - No strong evidence that the predictive ability is consistently better
  - Possibility of a rising trend in UU

Recommendations

- Results indicate current methodology of using model smoothing over 3 years is appropriate and fit for purpose

- Are DESC happy to continue with 3 year model smoothing for the Spring 2019 and Spring 2020 analysis ? Next review Autumn 2020 ?