Demand Estimation Sub Committee

Seasonal Normal Review 2020:

Review of CWV Formula

11th February 2019

Overview

- During 2019 DESC are reviewing / revising the Composite Weather Variable (CWV) formula **<u>AND</u>** the basis for deriving the Seasonal Normal Composite Weather Variable (SNCWV)

- Why ? - Reminder of DESC's UNC Section H obligations:

  - *"1.4.3 The Committee will, at appropriate frequencies determined by it, **review** and where appropriate **revise** (with effect from the start of a Gas Year) the **formula** by which the **Composite Weather Variable** for an LDZ will be determined."*

  - *"1.5.3 The Committee will, at appropriate frequencies determined by it, after consultation with the Uniform Network Code Committee, **review** and where appropriate **revise** (with effect from the start of a Gas Year) the **seasonal normal value** (for each Day in a year) of the **Composite Weather Variable** for an LDZ."*

Overview cont.

- The last review of the CWV formula and Seasonal Normal basis was completed by DESC in 2014. The revised values took effect from 1st October 2015 and remain in place today

- The CWV and SNCWV are key building blocks in the production of demand models, profiles, peak load factors and the NDM allocation formula

- For stability across the many industry processes impacted, DESC review the CWV and SNCWV, as a minimum, every 5 years. The current basis 'expires' on 30th September 2020

- The review of CWV and SNCWV needs to be completed during 2019 in order that the Spring modelling in 2020 can be performed using the new arrangements, when profiles for Gas Year 2020/21 will be produced

Overview - Timeline

| High Level Timeline of CWV / SNCWV Review |

Overview - Milestones

- At the 10th December 2018 meeting DESC approved the following high level approach and work plan for performing this analysis - major milestones below:

- **MILESTONE:** DESC to decide whether to revise existing **CWV** formula (1st April)

- **MILESTONE**: DESC define proposed **CWV** formula for next period i.e. GY 2020/21 onwards (8th July)

- **MILESTONE**: DESC confirm parameters for use in proposed **CWV** formula for Gas Year 2020/21 (7th October)

- **MILESTONE:** DESC decide whether to revise existing **SNCWV** (1st April)

- **MILESTONE:** DESC confirm revised **SNCWV** values (9th December)

Overview - DESC / TWG meeting Timetable 2019

High Level View of Seasonal Normal Review in 2019 - Key Checkpoints												

PHASE	JAN'19	FEB'19	MAR'19	APR'19	MAY'19	JUN'19	JUL'19	AUG'19	SEP'19	OCT'19	NOV'19	DEC'19
TWG REVIEW CWV and SNCWV	▒	▒	▒									
Update on Seasonal Normal Review (DESC)		11th Feb										
DESC MILESTONE				■								
DESC to decide on CWV and SNCWV Review				1st Apr								
TWG REVIEW OPTIONS FOR CWV FORMULA				▒	▒	▒						
Update on review of CWV formula (TWG)				24th Apr								
Update on review of CWV formula (TWG)					13th May							
DESC MILESTONE							■					
DESC define proposed CWV Formula (DESC)							8th Jul					
TWG COMPLETE CWV OPTIMISATION							▒	▒	▒			
Adhoc Meetings												
DESC MILESTONE										■		
DESC confirm parameters in CWV formula (DESC)										7th Oct		
TWG CALCULATE SNCWV										▒	▒	
Adhoc Meetings												
DESC MILESTONE												■
DESC confirm SNCWV values (DESC)												9th Dec

Assumptions

- The following assumptions have been made in relation to the whole Seasonal Normal Review work this year

- The algorithm defined in UNC and used in Gemini to estimate daily NDM demand (Nominations and Allocation) will for the foreseeable future continue to require a **single** view of weather (the CWV) for each **gas day** for each **LDZ**

- The CWV formula will therefore continue to be a single measure of daily weather in an LDZ, and defined in a manner to provide a linear relationship between the daily aggregate LDZ NDM demand* in the LDZ and the CWV
  - * From 1st June 2017 the daily aggregate NDM demand is a pseudo value of NDM demand + UIG

Objective of today

- For DESC to review the proposed approach for reviewing the Composite Weather Variable (CWV) formula in order to meet the following milestone:

  "DESC to decide whether to revise existing CWV formula (1ˢᵗ April)"

  - *"1.4.3 The Committee will, at appropriate frequencies determined by it, **review** and where appropriate **revise** (with effect from the start of a Gas Year) the **formula** by which the **Composite Weather Variable** for an LDZ will be determined."*

- For those parties new to DESC and the process of reviewing the CWV we felt it was important to provide some background on how the current CWV formula is designed prior to agreeing how DESC reviews its performance

- This background section will not be repeated in future meetings but will be available on the DESC homepage on the Joint Office website
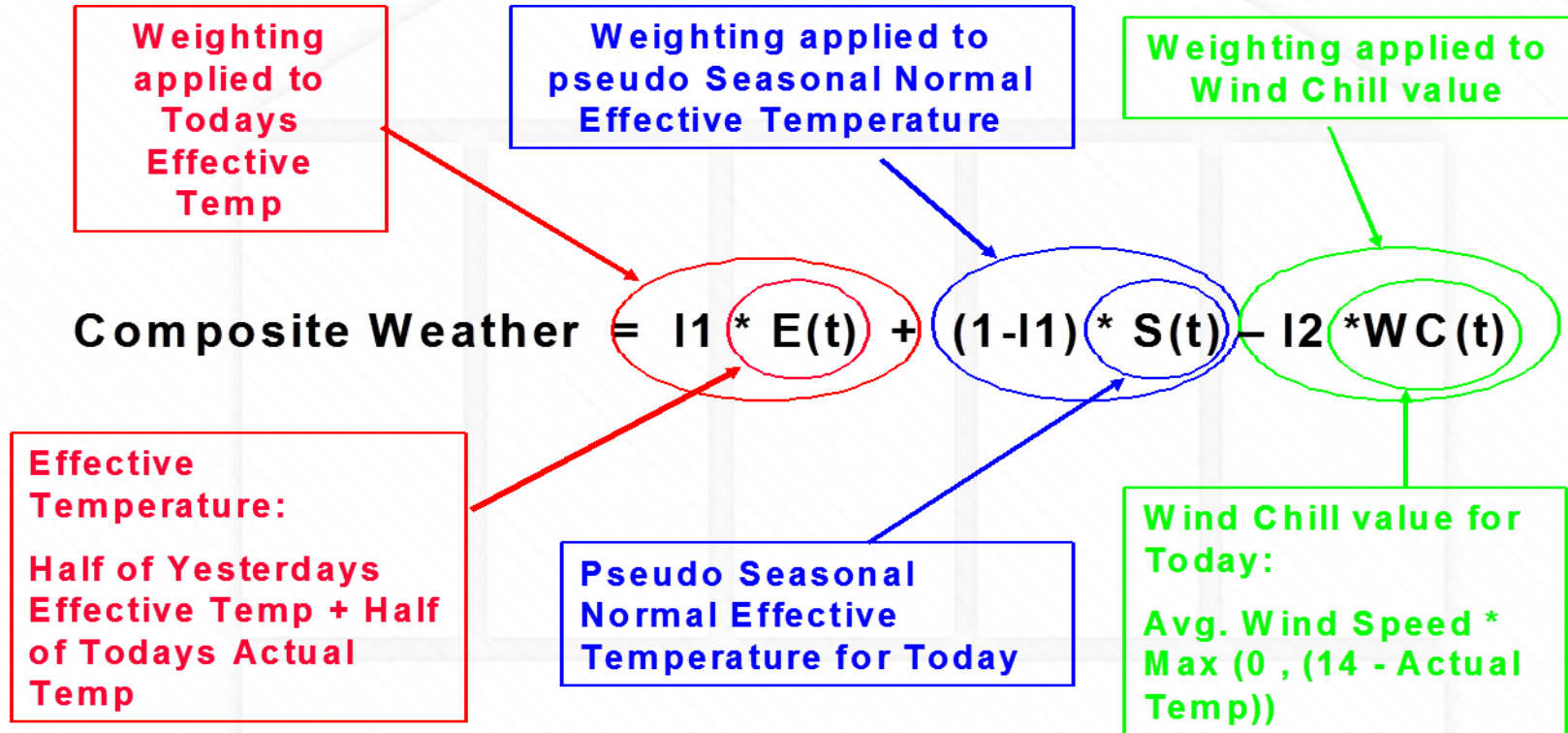
Background – CWV Formula Principles

- The CWV is a single measure of daily weather in each LDZ and is a function of effective temperature, wind speed and pseudo Seasonal Normal Effective Temperature (SNET)

- It is defined to give a linear relationship between **Monday to Thursday non holiday** daily aggregate NDM demand in the LDZ and the CWV

- It is important to produce a weather variable that provides the strongest possible 'fit' for the weather and demand models

- This relationship is key to providing the Demand Estimation parameters:

  – Annual Load Profile (ALP)

  – Daily Adjustment Factor (DAF)

  – Peak Load Factor (PLF)

Figure A3.8 - Demand against CWV, Monday to Thursday, Including Holidays Domestic Band

Linear relationship
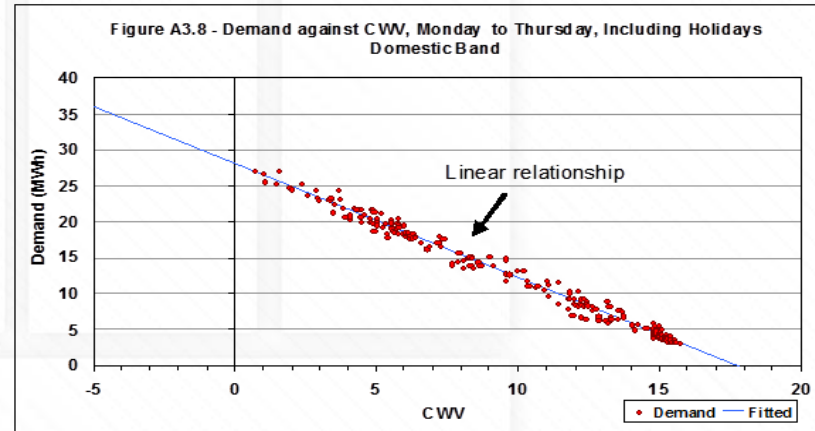
Background – Current CWV Formula (Part 1- CW)

- The formula is effectively split into 2 parts – part 1 below:

Weighting applied to Todays Effective Temp

Weighting applied to pseudo Seasonal Normal Effective Temperature

Weighting applied to Wind Chill value

$$\text{Composite Weather} = I1 * E(t) + (1-I1) * S(t) - I2 * WC(t)$$

Effective Temperature:

Half of Yesterdays Effective Temp + Half of Todays Actual Temp

Pseudo Seasonal Normal Effective Temperature for Today

Wind Chill value for Today:

Avg. Wind Speed * Max (0 , (14 - Actual Temp))

Background – Current CWV Formula (Part 2 - CWV)

- The formula is effectively split into 2 parts – part 2 below:

- Series of tests applied to the CW value (using parameters below) to determine if changes need to be made. Parameters to consider:

    - V0 – Cold Weather Upturn Threshold
    - V1 – Lower Warm Weather Cut-Off
    - V2 – Upper Warm Weather Cut-Off
    - Q – Slope relating to Warm Weather Cut-off

- **'Normal**': If CW is > cold weather threshold and < lower warm weather cut off: CWV = CW.

- **'Summer Transition'**: If CW is > lower warm weather cut-off but < upper warm weather cut-off:
CWV = Lower Cut-Off + Slope * (CW – Lower Cut-Off)

- **'Summer Cut-Off'**: If CW is > upper warm weather cut off:
CWV = Lower Cut-Off + Slope * (Upper Cut-Off – Lower Cut-Off)

- **'Cold Weather Upturn'**: If CW is < cold weather upturn threshold:
CWV = CW + Cold Weather sensitivity * (CW – Cold Weather Upturn Threshold)

# Background – Current CWV Formula Schematic
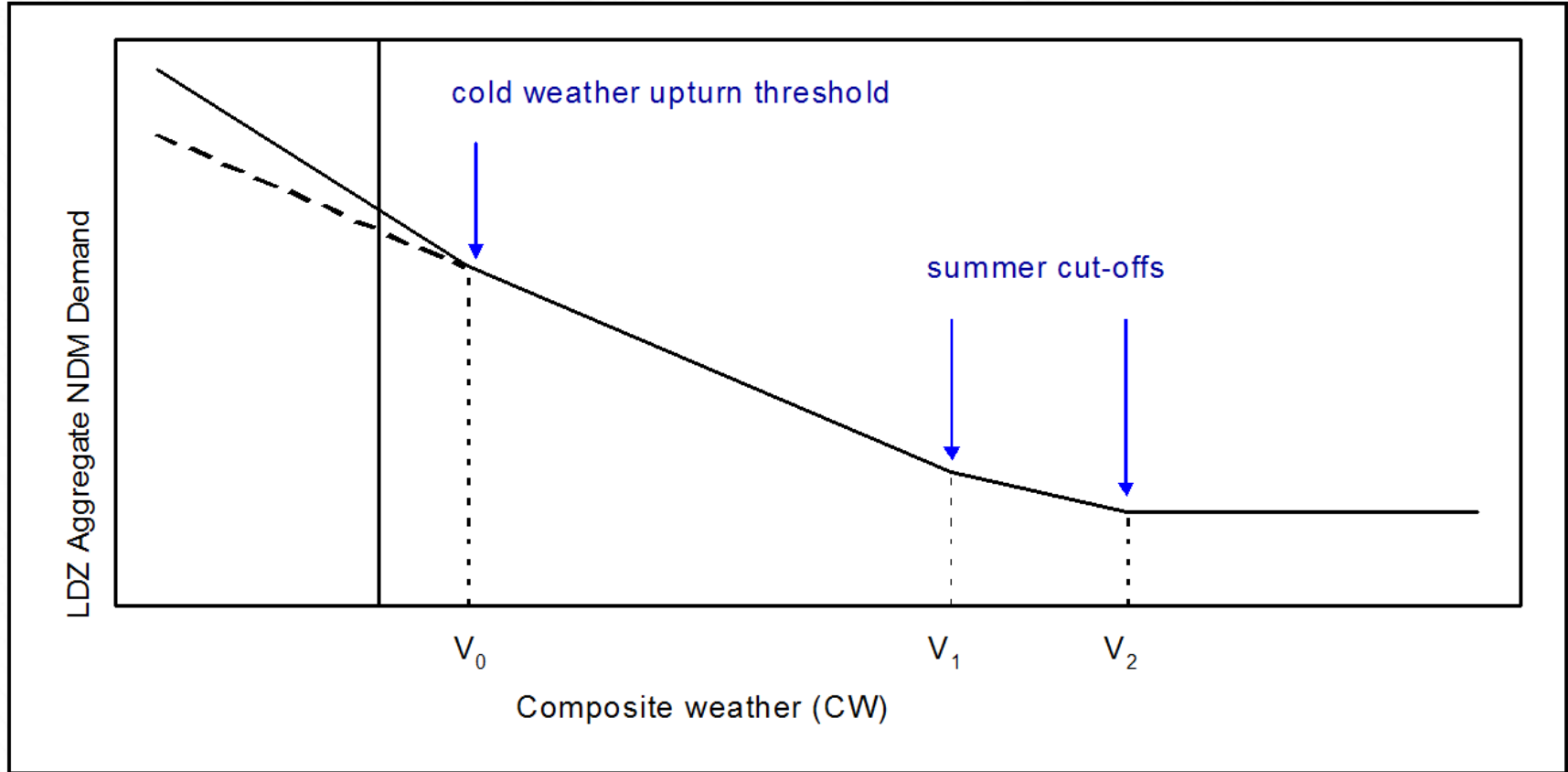
Background – Example of CWV Formula

- To bring the formula to 'life' we have used the aggregate NDM demand for LDZ NE for Gas Year 2017/18 and compared it with the component parts of the CWV formula to show how the various elements 'work' to produce a linear fit

- The charts on slide 14 show the same demand (y-axis) matched with the progressive states of the CWV formula (x-axis):

  – Actual Temperature (AT)
  – Effective Temperature (ET)
  – Composite Weather (CW)
  – Composite Weather Variable (CWV)

- The charts provide a useful visual representation of what the current CWV formula components are designed to achieve i.e. a liner relationship to demand
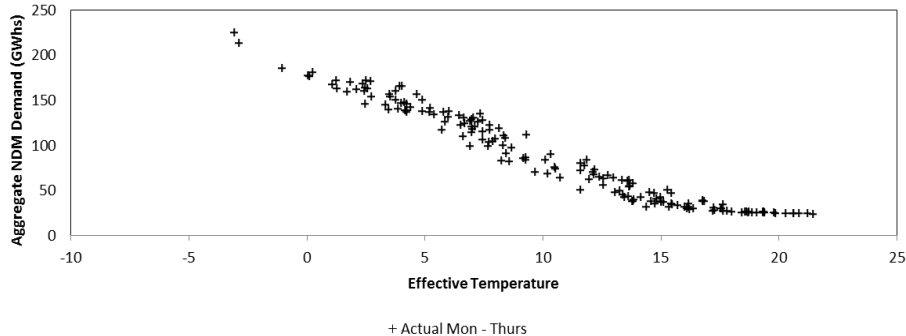
Background – Formula breakdown

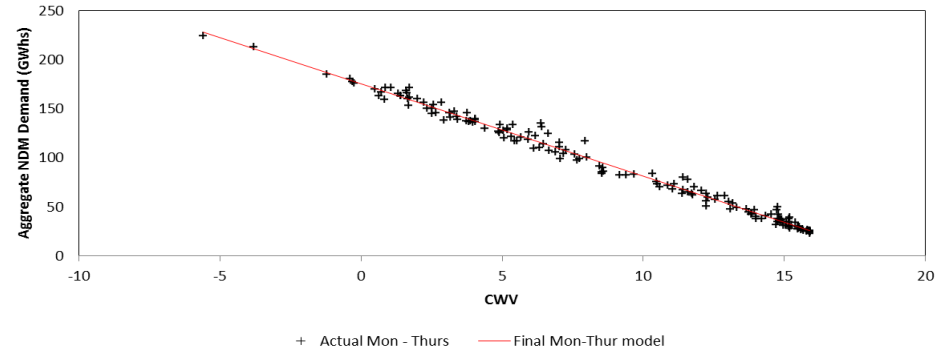LDZ: NE Gas Year 2017 Mon to Thurs non-holiday Demand against Actual Temperature (Weighted observations)
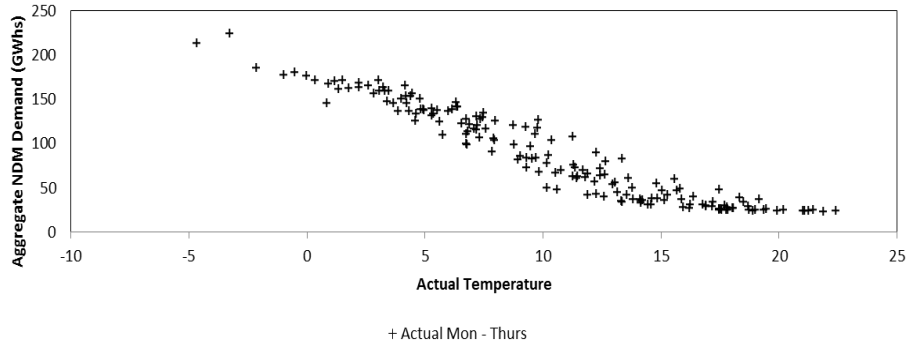
LDZ: NE Gas Year 2017 Mon to Thurs non-holiday Demand against CW
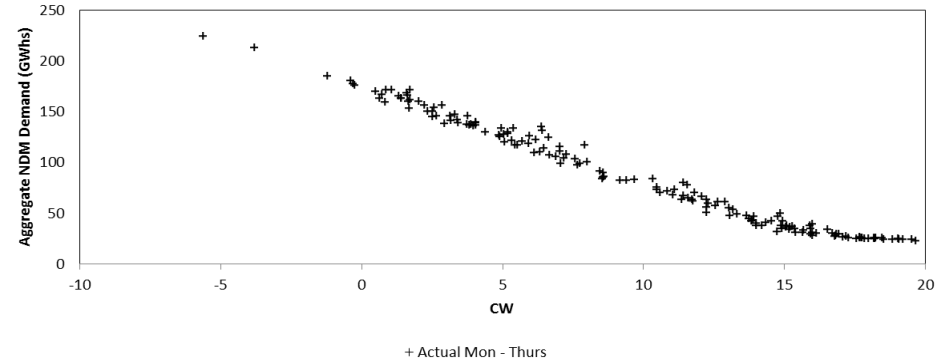
LDZ: NE Gas Year 2017 Mon to Thurs non-holiday Demand against Effective Temperature

LDZ: NE Gas Year 2017 Mon to Thurs non-holiday Demand against CWV

Approach to reviewing CWV Formula

- In previous iterations of this work (i.e. 2010, 2015) the underlying formula of the CWV was not assessed with the focus given to re-optimising the parameters within the existing formula

- Recent industry discussions, modifications have supported the potential use of additional weather data items being used in the derivation of the CWV

- So, in 2019, an additional step is required which is to review the current CWV formula ahead of any exercise to 're-optimise' the parameters

- DESC will be asked at 1st April meeting if it wishes to revise the current CWV formula – this presentation provides the suggested approach for helping DESC make this decision

Approach: Reviewing CWV Formula

- High level principles for approach:

  - Use the aggregate LDZ NDM demand data from the 4 complete Gas Years since the last review in 2014 – namely 2014/15, 2015/16, 2016/17 and 2017/18

  - Review performance of CWV by comparing aggregate NDM demand to CWV for each LDZ for each Gas Year

  - For each Gas Year assess the monthly performance of the CWV by reviewing the residuals

  - A variety of statistics and charts are offered here today for DESC to review ahead of analysis being performed for all LDZs and all 4 Gas Years

  - Are there additional 'tests' which DESC would like to use in order to help reach its decision at the end of the CWV formula review ?

- Key: Output will provide a benchmark to review any alternative proposals

Approach: Aggregate LDZ NDM Demands (1)

- Obtain the closed out (D+5) aggregate LDZ NDM demand data from 4 complete Gas Years since the last review in 2014 – namely 2014/15, 15/16, 16/17 & 17/18

- Upto 31st May 2017 the aggregate LDZ NDM demand is the result of a 'top down' calculation i.e. LDZ – DM - Shr
- Post 1st June 2017 the pseudo aggregate LDZ NDM demand is the result of the 'bottom up' calculation of NDM + UIG

- On occasion issues with LDZ and/or DM measurements are not resolved before D+5 which would mean the NDM demand includes these errors. Although not possible to extract all such errors, it is possible to identify obvious instances and remove prior to CWV analysis

- To achieve this we have run regressions using CWV and the aggregate LDZ NDM Demand for all LDZs for all 4 Gas Years and reviewed the output
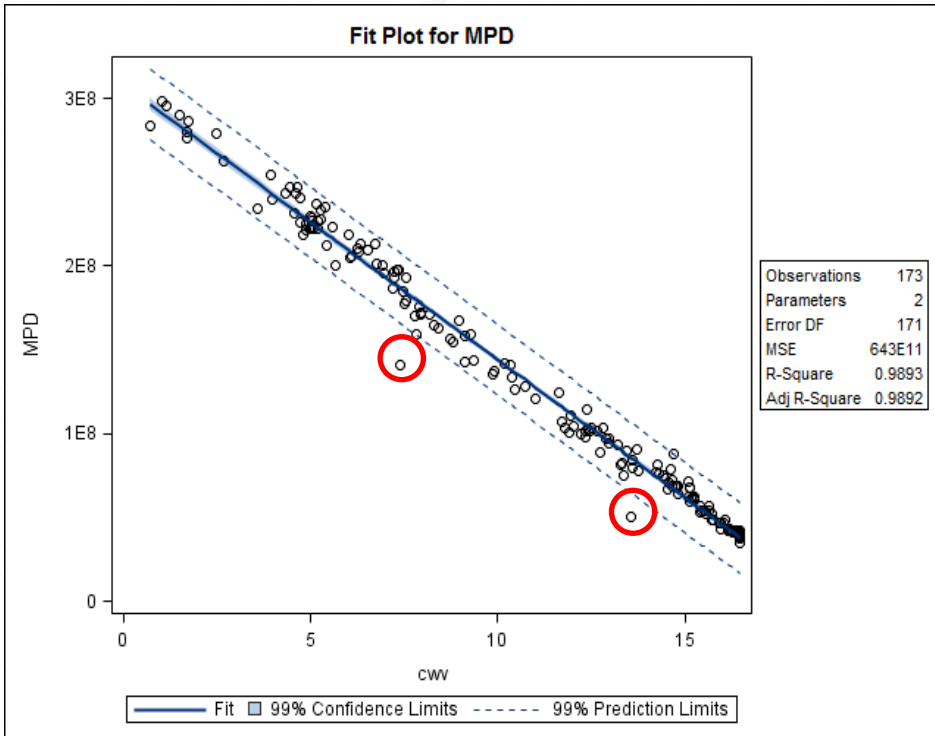
Approach: Aggregate LDZ NDM Demands (2)

- Overall there was a strong set of R-squared values (vast majority 98%+) across all the LDZs

- As well as viewing all of the charts individually we added "99% prediction limits" and reviewed the instances which were outside these tolerances

- A small number of outliers were identified and removed from the analysis

- Although, we were anticipating issues with June to September 2017 due to known DM issues post Nexus implementation there were no obvious data issues and so we propose to leave these days in the subsequent analysis

- The next slide provides an example of the charts we reviewed and the results for those LDZs/Gas Years where data points were removed are highlighted, in all instances the R-squared value improved

Approach: Aggregate LDZ NDM Demands (3)

Example of regression chart with prediction limits and outliers - LDZ: SE Gas Year 2014

Figure in brackets show percentage point change – all improvements

Fit Plot for MPD

Observations	173
Parameters	2
Error DF	171
MSE	643E11
R-Square	0.9893
Adj R-Square	0.9892

Fit ☐ 99% Confidence Limits - - - - 99% Prediction Limits

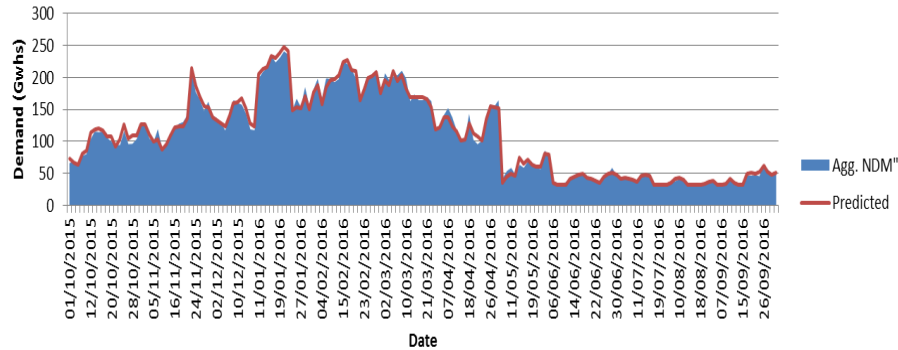|	Gas Year			
LDZ	2014	2015	2016	2017
SC	98.81%	98.59%	98.86%	99.02%
NO	98.72% (0.13%)	98.43%	98.29%	98.72%
NW	98.34%	98.66%	98.24%	99.06%
NE	98.36%	98.63%	98.28%	99.07%
EM	99.14%	99.05%	98.97%	99.29%
WM	99.01%	99.15%	99.01%	99.29%
WN	98.28%	98.71% (0.52%)	97.70%	98.34%
WS	98.20% (0.18%)	98.40%	97.42%	98.75%
EA	99.31%	99.25%	98.94%	99.17% (0.13%)
NT	99.39%	99.45%	99.25%	99.43% (0.11%)
SE	99.25% (0.32%)	99.30%	98.86%	99.37% (0.29%)
SO	99.29%	99.20%	99.06%	99.22%
SW	99.02%	99.13%	98.81%	99.24% (0.10%)
Min	98.20%	98.40%	97.42%	98.34%
Max	99.39%	99.45%	99.25%	99.43%

Approach: Suggested Analysis

- Once satisfied with the aggregate LDZ NDM demand data we can review the 'performance' of the CWV

- Use regression analysis to compare aggregate LDZ NDM demand (Mon-Thurs non-holiday) to CWV for each LDZ for each Gas Year and summarise the R-squared results

- It is important to understand where and when the CWV is not performing as well as it could. We propose analysis of residuals

- For each Gas Year we will provide a number of reports/charts for each LDZ and for each of the four gas years. An example of the type of charts we could provide follow and is for LDZ WM Gas Year 2015/16

- We would like DESC/TWG to review and advise which reports/charts they would like to see for the full set of results and formal CWV formula review

LDZ: WM Gas Year: 2015 Agg. NDM Demand
(Mon-Thurs non.holiday)

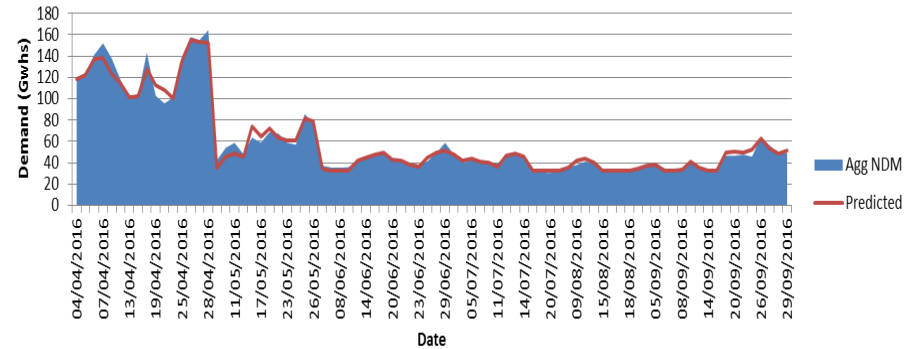$R^2 = 0.9915$

• Agg. NDM Demand ——— Linear (Agg. NDM Demand)
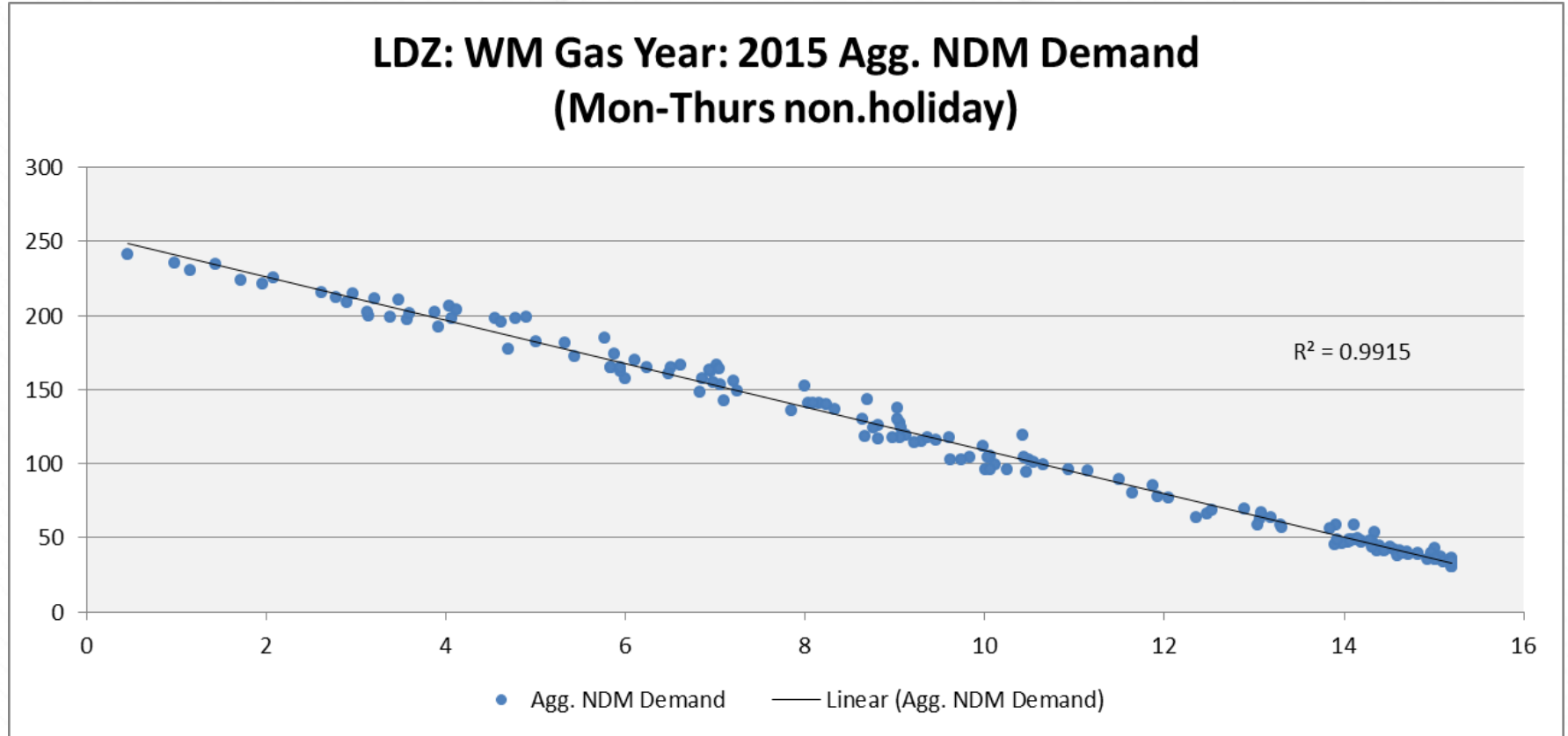
LDZ: WM Gas Year: 2015 Demand Vs Predicted

LDZ: WM Gas Year: 2015 Winter: Demand Vs Predicted
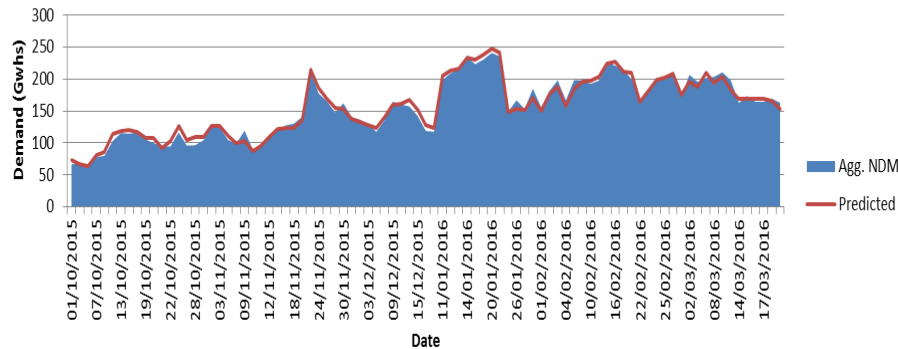
LDZ: WM Gas Year: 2015 Summer: Demand Vs Predicted

Summary of CWV performance by month and quarter

LDZ	Month	Count	% Residual	% Inaccuracy
WM	201510	17	-5.44	7.11
WM	201511	17	0.48	4.82
WM	201512	11	-2.21	4.37
WM	201601	12	-0.39	3.65
WM	201602	17	0.79	3.02
WM	201603	13	1.69	4.19
WM	201604	16	2.57	6.43
WM	201605	12	0.96	9.71
WM	201606	16	2.20	5.78
WM	201607	12	-1.15	4.25
WM	201608	9	-2.24	4.88
WM	201609	17	-1.22	5.86

LDZ	Quarter	Count	% Residual	% Inaccuracy
WM	DEC – FEB	40	-0.23	3.54
WM	MAR – MAY	41	1.93	5.91
WM	JUN – AUG	37	0.17	5.19
WM	SEP – NOV	51	-1.87	6.17

Biggest 20 residuals (%)

Rank	Position	Residual %	Date	CWV	SNCWV	WCF
1	108	-17.10%	Mon 16/05/2016	12.36	12.5	-0.14
2	106	16.68%	Wed 11/05/2016	14.11	12.07	2.04
3	104	16.14%	Mon 09/05/2016	15.01	11.88	3.13
4	105	15.65%	Tue 10/05/2016	14.34	11.97	2.37
5	22	13.88%	Mon 09/11/2015	10.43	7.18	3.25
6	165	-13.55%	Thu 22/09/2016	13.9	13.53	0.37
7	98	-12.99%	Wed 20/04/2016	10.06	9.9	0.16
8	16	-12.89%	Wed 28/10/2015	10.01	9.01	1
9	130	11.86%	Wed 29/06/2016	13.91	14.72	-0.81
10	6	-11.11%	Mon 12/10/2015	9.62	11.08	-1.46
11	92	10.57%	Mon 11/04/2016	9.03	8.63	0.4
12	96	10.51%	Mon 18/04/2016	8.69	9.7	-1.01
13	145	-10.29%	Tue 09/08/2016	14.59	14.99	-0.4
14	1	-10.09%	Thu 01/10/2015	12.47	12.44	0.03
15	15	-9.87%	Tue 27/10/2015	10.25	9.18	1.07
16	109	-9.65%	Tue 17/05/2016	13.04	12.58	0.46
17	97	-9.55%	Tue 19/04/2016	9.74	9.8	-0.06
18	91	9.06%	Thu 07/04/2016	7.99	8.22	-0.23
19	163	-9.02%	Tue 20/09/2016	13.98	13.67	0.31
20	128	-8.76%	Mon 27/06/2016	14.37	14.7	-0.33

LDZ: WM Average Monthly Residuals % by Gas Year
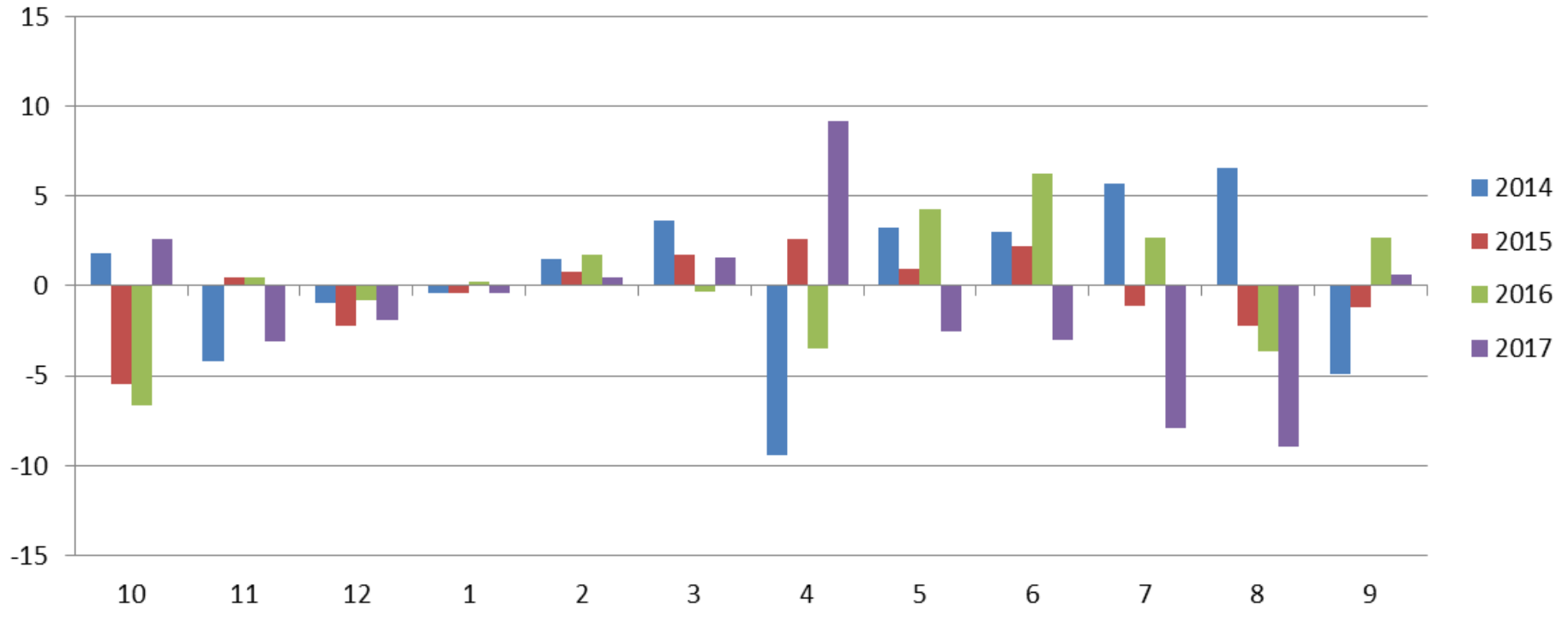
LDZ WM Average Monthly Residuals %
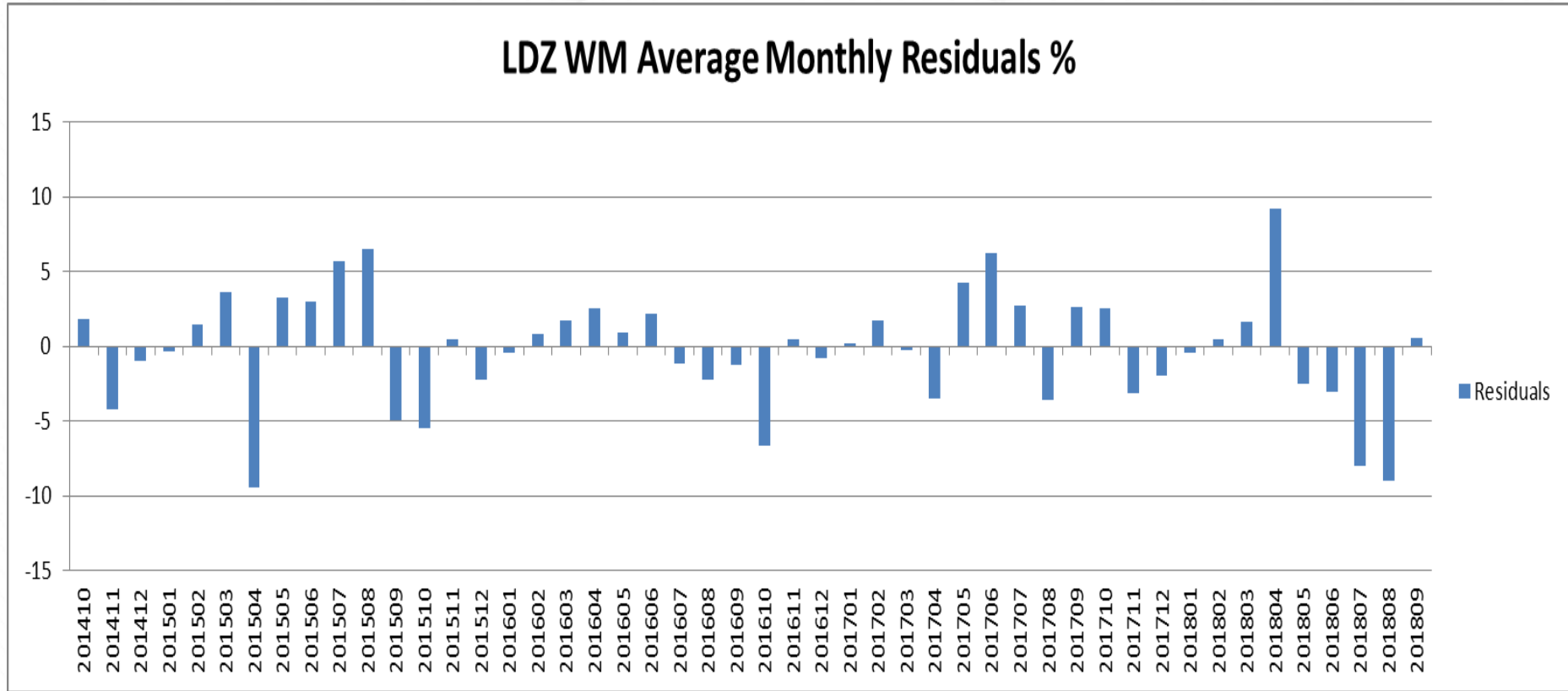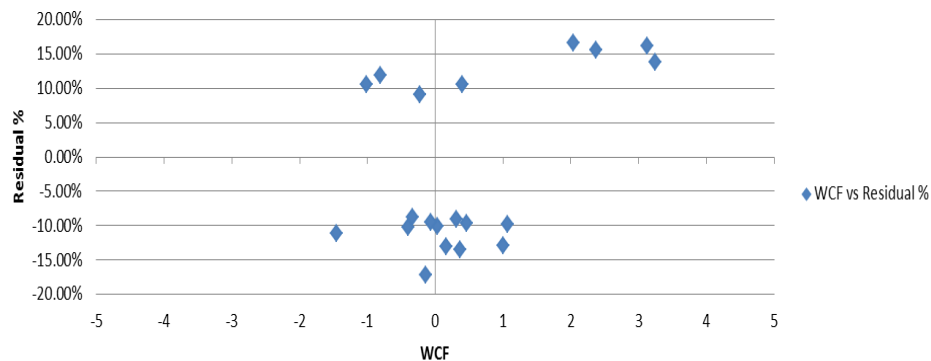
LDZ: WM Gas Year: 2015 Timeseries Residual %
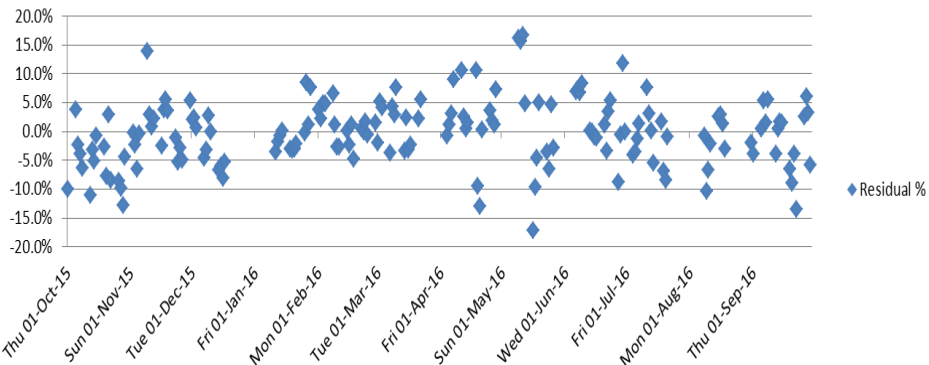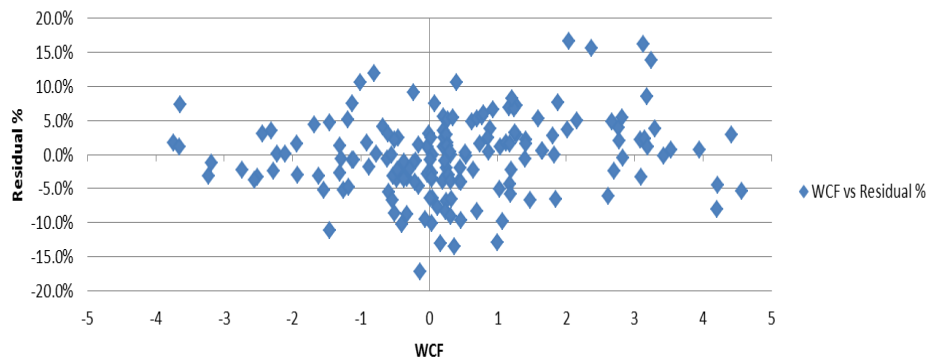
LDZ: WM Gas Year: 2015 WCF vs Res % of 20 Largest Residuals (+ / -)

LDZ: WM Gas Year: 2015 WCF vs Res %

DESC Views

- How do DESC want to decide on whether to retain or revise existing CWV formula ?

- Are you satisfied forming a view based on the results suggested here or is there an additional 'Test' which DESC would like to use in order to help reach its decision at the end of the CWV formula review ?

- What are DESC's views / thoughts ?

Next Steps

- TWG / DESC to agree on approach / 'template' for analysis

- CDSP to complete analysis for all LDZs for all 4 Gas Years and publish for TWG review - correspondence or teleconference for follow up ahead of DESC meeting on 1st April ?

- CDSP to publish aggregate LDZ NDM demand data used in analysis so its available to TWG / DESC for their own review

- DESC at its meeting on 1st April to formally decide whether to retain or revise existing CWV formula

- CDSP to consider analysis of current SNCWV