Demand Estimation Sub Committee

Seasonal Normal Review 2020:

Review of Seasonal Normal Basis (SNCWV) – Part 1

9th December 2019

Overview – DESC Obligations

- During 2019 DESC are reviewing / revising the Composite Weather Variable (CWV) formula AND 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."

- More information on background to Seasonal Normal Review 2020 here.

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 consider a revision to the existing **CWV** formula and confirm the template for its 'benchmark' results (1st April 2019) ✓

- **MILESTONE**: DESC define proposed **CWV** formula for next period i.e. GY 2020/21 onwards (8th July 2019) ✓

- **MILESTONE**: DESC confirm parameters for use in proposed **CWV** formula for Gas Year 2020/21 (7th October 2019): ✓

- **MILESTONE:** DESC decide to revise existing **SNCWV** (8th July 2019) ✓

- **MILESTONE:** DESC confirm revised **SNCWV** values (9th December 2019)

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 confirm plan to Review 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							
Update on review of CWV formula (TWG)						10th Jun						
DESC MILESTONE												
DESC define proposed CWV Formula (DESC)							8th Jul					
TWG COMPLETE CWV OPTIMISATION												
Adhoc Meetings									23rd Sep			
DESC MILESTONE												
DESC confirm parameters in CWV formula (DESC)										7th Oct		
TWG CALCULATE SNCWV												
Review High Level Approach to SNCWV (DESC)											5th Nov	
DESC MILESTONE												
DESC confirm SNCWV values (DESC)												9th Dec

- Last meeting on 5th November DESC approved the high level approach to deriving the SNCWV.

Objective

- At today's DESC meeting, members to consider recommendations for revised SNCWV values in order to seek approval for their use from 1st October 2020.

- To support this, there are 2 presentations which cover the following:

  - Presentation 1:
    - Recap on modified CWV formula and Parameter optimisation
    - Summary of work carried out to derive new history of Actual CWVs
    - Review of 'CWV composition' in new history

  - Presentation 2:
    - Recap of approved methodology for deriving Seasonal Normal CWV
    - Overview of data used and Results
    - Conclusions and Next Steps

Recap – Agreed CWV Formula

- CWV Formula to be used effective from 1st October 2020.

$$CW_t = I_1 * E_t + (1.0 - I_1) * S_t - I_2 * \max(0, W_t - W_0) * \max(0, T_0 - AT_t) + S_0 * SR_t + P_0 * P_t$$

$$CWV_t = V_1 + q * (V_2 - V_1) \quad if\ V_2 \le CW_t \quad \text{(Summer Cut-off)}$$

$$CWV_t = V_1 + q * (CW_t - V_1) \quad if\ V_1 < CW_t < V_2 \quad \text{(Transition)}$$

$$CWV_t = CW_t \quad if\ V_0 \le CW_t \le V_1 \quad \text{(Normal)}$$

$$CWV_t = CW_t + I_3 * (CW_t - V_0) \quad if\ V_0 > CW_t \quad \text{(Cold weather upturn)}$$

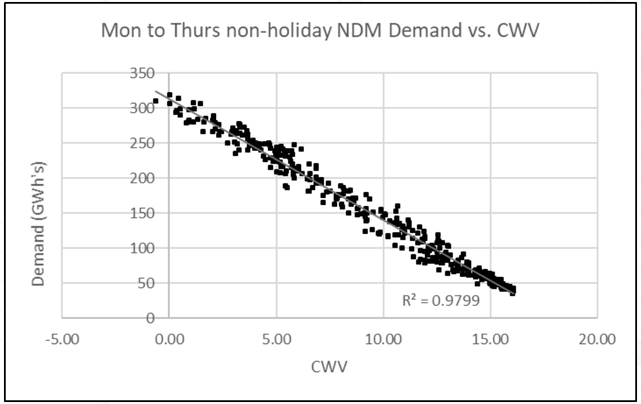
- CWV Parameters to be used effective from 1st October 2020 as agreed by DESC.

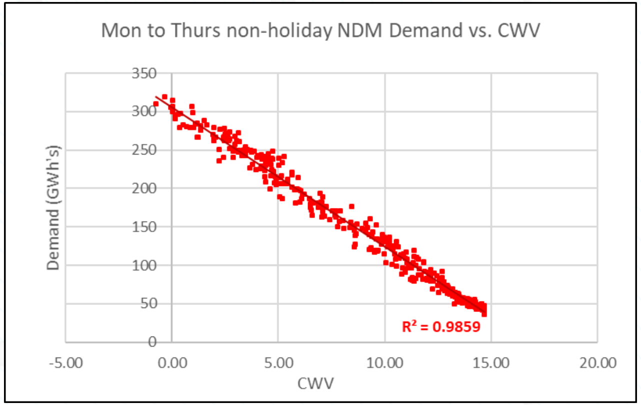
LDZ	Weather Station	ET/AT Weight	I_1	I_2	I_3	V_0	V_1	V_2	q	W_0	T_0	S_0	P_0
EA	London Heathrow	0.460	0.723	0.015	0.109	-0.235	15.131	18.885	0.368	-0.477	12.650	0.635	0.000
EM	Nottingham Watnall	0.480	0.689	0.010	0.138	-1.344	13.008	16.897	0.424	-2.417	17.377	0.698	0.000
NE	Nottingham Watnall	0.459	0.672	0.009	0.083	-1.261	12.924	16.679	0.446	-1.652	21.596	0.568	0.000
NO	Albermarle Barracks (Solar Durham)	0.492	0.646	0.008	0.126	5.000	12.005	15.779	0.438	-0.894	16.657	0.950	0.000
NT	London Heathrow	0.473	0.715	0.015	0.066	4.898	15.029	19.184	0.429	-3.811	12.833	0.695	0.000
NW	Rostherne No 2	0.498	0.646	0.009	0.315	2.694	12.775	16.466	0.513	-5.000	21.312	0.802	0.000
SC	Glasgow Bishopton	0.505	0.680	0.011	0.000	1.053	12.590	16.402	0.509	-2.992	15.476	0.507	0.000
SE	London Heathrow	0.484	0.772	0.006	0.266	1.335	13.996	18.523	0.375	-0.721	21.613	0.566	0.000
SO	Southampton Oceanographic Institute	0.438	0.692	0.015	0.405	0.141	14.745	18.715	0.345	-2.076	11.978	0.559	0.000
SW	Yeovilton Weather Station	0.448	0.623	0.008	0.258	3.476	13.254	17.898	0.337	0.705	21.707	0.801	0.000
WM	Birmingham Winterbourne 2 (Wind speeds/ Solar Coleshill)	0.471	0.692	0.010	0.163	4.385	13.392	17.480	0.368	-3.619	17.569	0.678	0.000
WN	Rostherne No 2	0.482	0.618	0.009	0.324	3.773	13.477	16.987	0.445	-3.926	18.249	0.679	0.000
WS	St. Athan	0.543	0.657	0.008	0.079	1.797	13.826	17.186	0.384	-1.910	17.068	0.776	0.000

Recap – Use of Solar Radiation

- The objective of including a Solar Radiation term and the optimisation of the CWV parameters was to produce a CWV which displays a closer linear relationship when analysed against observed aggregate NDM demand.

- Materials presented to DESC on 7th October 2019 show that this has been achieved, which resulted in the approval of the new parameters to be used effective from 1st October 2020.





Revision of Actual CWV History

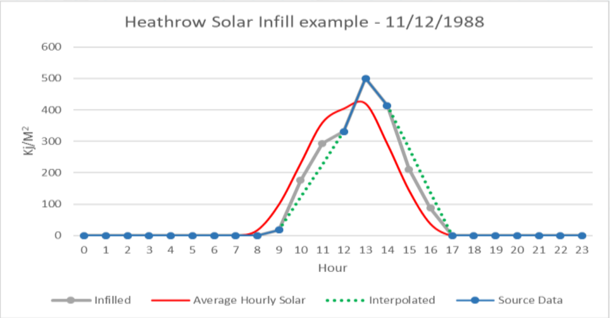
- Following confirmation of the new CWV formula and optimised parameters, the weather history back to 1960 (required for Demand Estimation modelling) has been re-stated using the actual Temperatures, Wind Speeds <u>and</u> now Solar Radiation.

- Prior to calculating the CWV history, there is a requirement to ensure all the data for each weather variable used is complete.

- Due to the inconsistent history of Solar Radiation observations in the WSSM datasets, an infill methodology was devised by Xoserve and agreed by DESC via correspondence .

- Reminder of the formula used to calculate missing values and example is provided below:

$$Infill\ Value = Interpolated\ Value * \frac{Number\ of\ Actual\ Reads}{Expected\ Solar\ Hours} + Average\ Hourly\ Solar * \frac{Number\ of\ Null\ Reads}{Expected\ Solar\ Hours}$$



Revision of Actual CWV History

- During the course of infilling the Solar radiation history, a number of records were identified which appeared to be showing erroneous observations overnight (where values of zero would be expected).

- After consultation with our weather service provider it was decided that these records would be removed and replaced using the aforementioned infill methodology. The overall effect to the final solar term is negligible.

- The table below shows the number of erroneous observations removed, and the total number of missing or removed records infilled (including as a percentage of total records) for each gas industry weather station.

LDZ	Weather Station	Removed Records	Infilled Records
WM	Coleshill	257 (0.05%)	1,785 (0.35%)
NO	Durham	111 (0.02%)	45,526 (8.84%)
SC	Glasgow Bishopton	242 (0.05%)	44,970 (8.73%)
EA, NT, SE	London Heathrow	56 (0.01%)	1,760 (0.34%)
EM, NE	Nottingham Watnall	842 (0.16%)	212,544 (41.27%)
NW, WN	Rostherne No 2	58 (0.01%)	192,392 (37.36%)
SO	Southampton	205 (0.04%)	2,928 (0.57%)
WS	St Athan	594 (0.12%)	14,092 (2.74%)
SW	Yeovilton	160 (0.03%)	310,015 (60.20%)

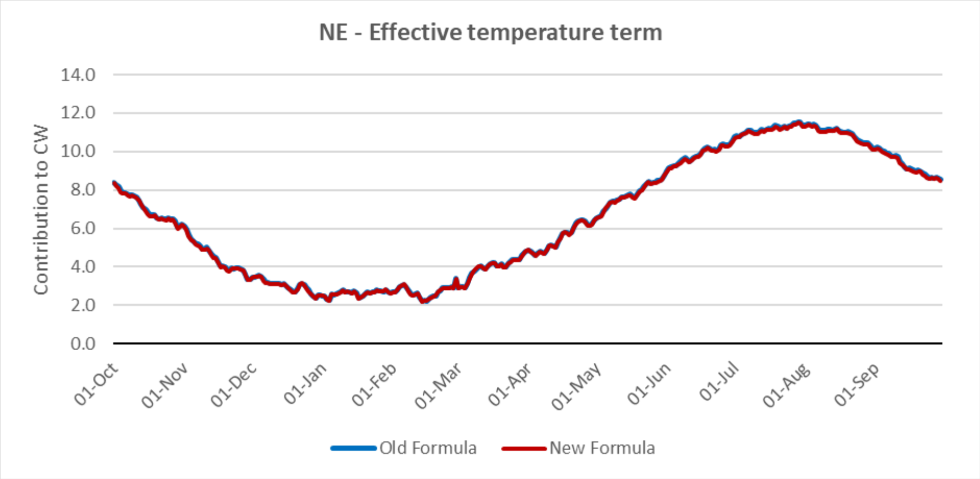
Change in CWV Formula composition

- As discussed during the review of the new CWV formula and the new optimised parameters it should be appreciated that the composition of the CWV formula has undergone significant change – e.g. addition of the Solar Radiation term and the results driven methodology of parameter optimisation, which has led to large movements in certain outcomes.

- Caution must therefore be taken when attempting to draw meaningful conclusions from directly comparing the profile and values from the old formula and parameters, to the new version.

- In order to appreciate and demonstrate the changes in the underlying structure of the ‘Old’ and ‘New’ formula a summary of the revised CWV history (1960 to 2017/18) has been provided over slides 11 to 19 using LDZ ‘NE’ as an example. Similar graphs for all other LDZs are available upon request.

NE - Effective Temperature Term



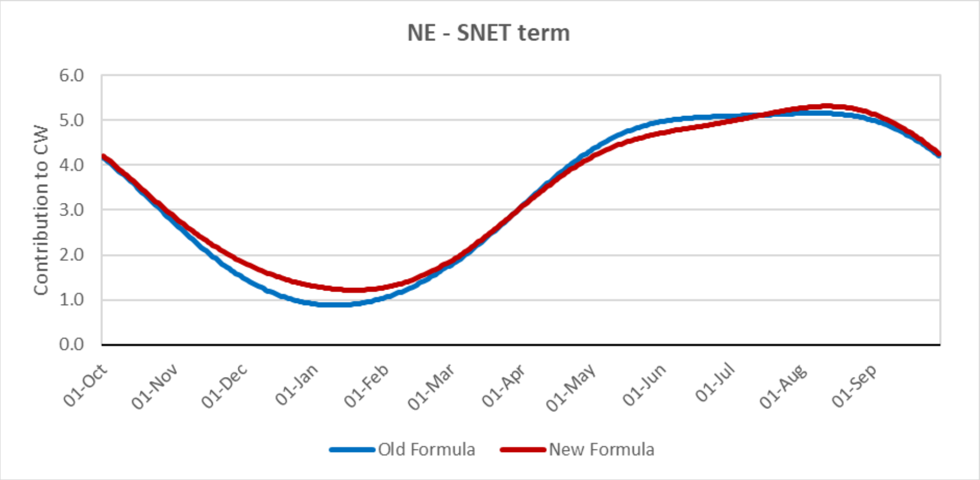
CWV Formula	Effective Temperature/AT Weight	Effective Temperature Weight (I1)
2015	0.5	0.676
2020	0.459	0.672

$$CW_t = I_1 * E_t + (1.0 - I_1) * S_t - I_2 * \max(0, W_t - W_0) * \max(0, T_0 - AT_t) + S_0 * SR_t + P_0 * P_t$$

- A slight reduction in the Effective Temperature term can be observed when comparing the Old and New formulas. This is driven by the slight decrease in LDZ NE's I_1 value.

- Although the Effective Temperature weight has also decreased this will not necessarily cause a decrease in the Effective Temperature term, only that the preceding Effective Temperatures are more influenced by the Actual Temperatures.

NE – SNET Term

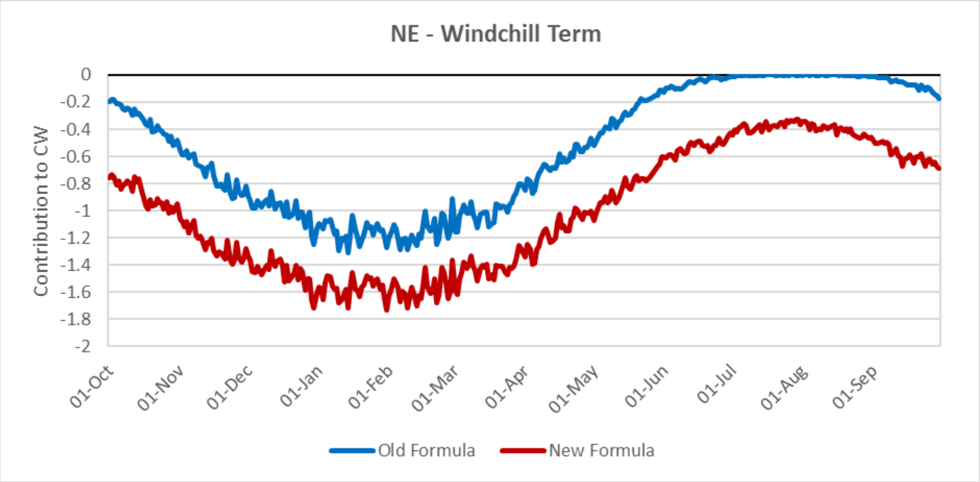


CWV Formula	Effective Temperature Weight (I1)
2015	0.676
2020	0.672

$$CW_t = I_1 * E_t + (1.0 - I_1) * S_t - I_2 * \max(0, W_t - W_{0)} * \max(0, T_0 - AT_t) + S_0 * SR_t + P_0 * P_t$$

- SNET term can be observed to contribute more to the final CW during period November to March.
- A small change has been observed in Effective Temperature weight parameter – (0.676 to 0.672).
- Changes seen in SNET term above are also derived from the re-optimisation of the SNET term during the optimisation phase.

NE – Windchill Term



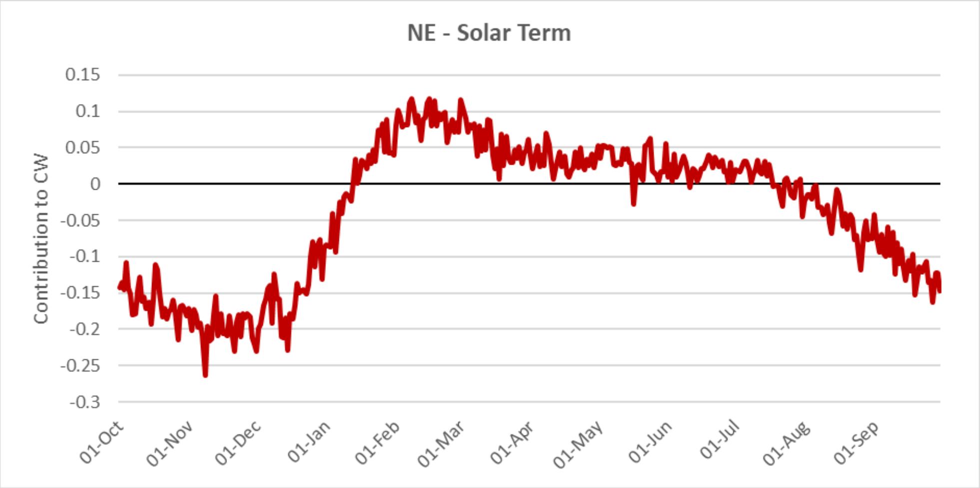
CWV Formula	Wind Chill Weight (I2)	Wind Chill Wind Cut-Off (W0)	Wind Chill Temperature Cut-Off (T0)
2015	0.0159	0	14
2020	0.009	-1.652	21.596

$$CW_t = I_1 * E_t + (1.0 - I_1) * S_t - I_2 * \max(0, W_t - W_0) * \max(0, T_0 - AT_t) + S_0 * SR_t + P_0 * P_t$$

- Due to the lowering of the Wind Chill Cut-Off, and the increase in the Wind-Chill Temperature Cut Off, the Wind Chill term is now applicable over a greater range of Wind Speeds and Temperatures. Consequently, non-zero values for this term are seen throughout the year

- The Decrease in W_0 and Increase in T_0 have also resulted in larger values for the Wind Chill term, as seen in the graph above.

NE – Solar Radiation Term

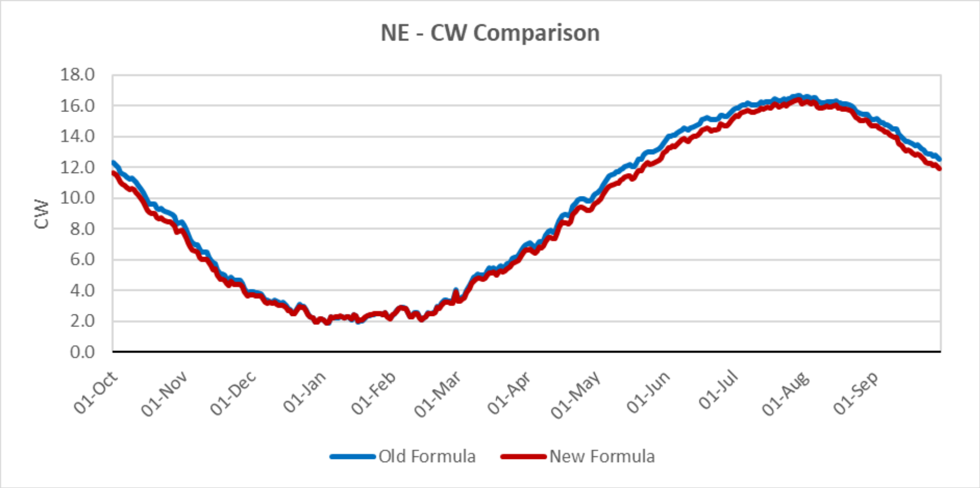


CWV Formula	Solar Radiance Effect (S0)
2015	n/a
2020	0.568

$$CW_t = I_1 * E_t + (1.0 - I_1) * S_t - I_2 * \max(0, W_t - W_0) * \max(0, T_0 - AT_t) + S_0 * SR_t + P_0 * P_t$$

- This chart shows the overall impact of the Solar Radiation term on the CW term which precedes the CWV calculation. The effects of demand correction can be seen mainly during the months of September to January, where the optimised SNES profile has caused the Solar Radiation term to be consistently negative.

NE – CW Term

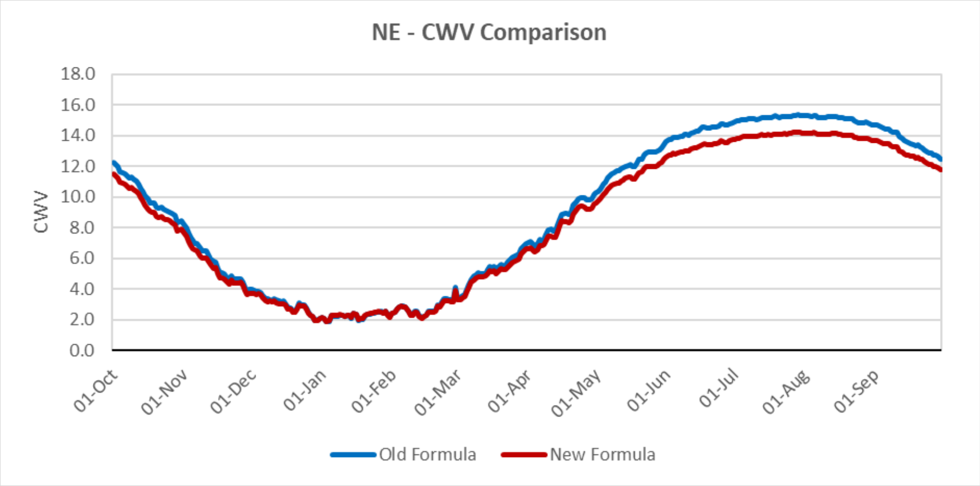


$$CW_t = I_1 * E_t + (1.0 - I_1) * S_t - I_2 * \max(0, W_t - W_{0)} * \max(0, T_0 - AT_t) + S_0 * SR_t + P_0 * P_t$$

- This chart shows a comparison of the CW terms once all preceding terms have been summed, this is prior to application of the transition periods.

- Overall, the CW is showing a similar profile in the old and new basis' of CWV during the winter months. A decrease over the period April to November can be observed.

NE – CWV



- This chart shows the final daily average CWV value following the application of the Summer Cut-Off, Transition and Cold Weather Upturn definitions.
- As the CWs are relatively similar, a large portion of changes in the CWV can be explained by the changes to the 'Threshold parameters' V_0, V_1, V_2, and q which have been optimised against demand.

$CWV_t = V_1 + q * (V_2 - V_1)$	$if\ V_2 \leq CW_t$	(Summer Cut-off)
$CWV_t = V_1 + q * (CW_t - V_1)$	$if\ V_1 < CW_t < V_2$	(Transition)
$CWV_t = CW_t$	$if\ V_0 \leq CW_t \leq V_1$	(Normal)
$CWV_t = CW_t + I_3 * (CW_t - V_0)$	$if\ V_0 > CW_t$	(Cold weather upturn)

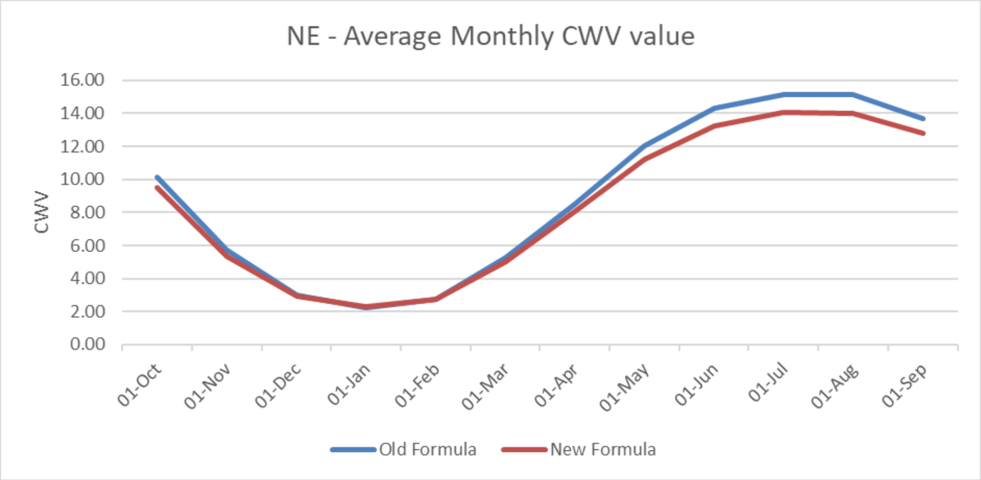
CWV Formula	Cold Weather Upturn Threshold (V0)	Lower Warm Weather Cut-Off (V1)	Upper Warm Weather Cut-Off (V2)	Slope Relating to Warm Weather Cut-Off (q)
2015	0	14.7	17.9	0.38
2020	-1.261	12.924	16.679	0.446

NE – CWV Values by Phase (%)

Phase	Old Formula	New Formula
Summer cut-off	2.83%	5.91%
Transition	19.08%	23.44%
Normal	74.60%	69.33%
Cold weather upturn	3.49%	1.32%

- When recalculating historical CWV values using the new formula and parameters, 5.91% of days have reached the Summer Cut-Off value and have subsequently been assigned the Maximum CWV value, up from 2.83% under the previous formula and parameters.
- The Maximum CWV value for LDZ NE has been reduced from 15.92 to 14.60.
- A combination of the above factors has contributed to the lowering of daily average CWV values over the summer period, as seen on the previous slide.

NE – Monthly Average CWV

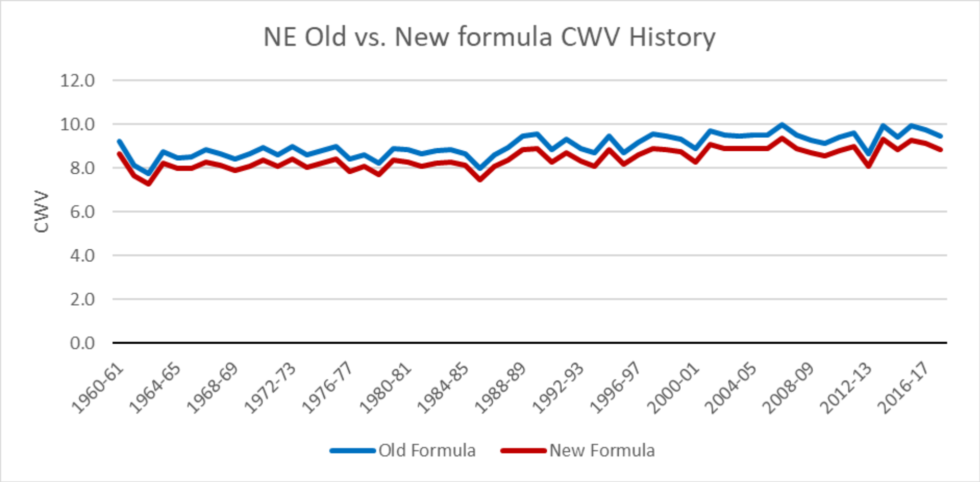


Month	Old Formula	New Formula
October	10.16	9.53
November	5.73	5.35
December	3.03	2.92
January	2.26	2.28
February	2.77	2.71
March	5.25	4.99
April	8.51	8.02
May	12.03	11.22
June	14.31	13.24
July	15.16	14.04
August	15.10	14.02
September	13.67	12.80

- When taken across the entire period 01/10/1960 to 30/09/2018, the monthly average CWV value remains relatively similar during the period December to February.

- Larger changes can be observed during the shoulder periods and summer months, this is in large part due to the reduction in the warm weather cut off values, as previously mentioned.

NE – Yearly average CWV



- The yearly average CWV value also shows a reduction, as expected this trend is followed throughout the entire history.
- Although the CWV history shown above uses Actual temperatures, the same trend is expected to be seen in the recalculation of the Seasonal Normal basis.

Average Monthly CWV Movement

	EA	EM	NE	NO	NT	NW	SC	SE	SO	SW	WM	WN	WS
October	0.06	-0.28	-0.63	-0.45	-0.05	-0.94	-0.18	-0.36	0.12	-0.44	-0.43	-0.25	-0.37
November	0.11	-0.22	-0.38	-0.38	-0.14	-0.87	-0.43	-0.05	0.21	-0.22	-0.57	-0.16	0.00
December	0.11	-0.11	-0.11	-0.37	-0.24	-0.79	-0.47	0.13	0.19	-0.18	-0.73	-0.26	0.25
January	0.21	0.01	0.02	-0.31	-0.21	-0.69	-0.33	0.32	0.17	-0.16	-0.83	-0.33	0.31
February	0.20	-0.05	-0.06	-0.29	-0.25	-0.63	-0.40	0.26	0.10	-0.10	-0.94	-0.37	0.15
March	0.09	-0.13	-0.26	-0.32	-0.25	-0.72	-0.46	-0.01	0.09	-0.14	-0.76	-0.43	0.01
April	-0.06	-0.18	-0.49	-0.44	-0.21	-0.84	-0.38	-0.30	0.07	-0.28	-0.51	-0.48	-0.17
May	-0.11	-0.41	-0.81	-0.74	-0.10	-1.13	-0.33	-0.60	0.00	-0.59	-0.51	-0.66	-0.56
June	-0.07	-0.61	-1.07	-0.83	-0.02	-1.33	-0.34	-0.76	-0.08	-0.81	-0.55	-0.90	-0.86
July	-0.07	-0.58	-1.12	-0.69	0.05	-1.30	-0.36	-0.81	-0.07	-0.85	-0.48	-0.96	-0.93
August	-0.08	-0.52	-1.08	-0.61	0.05	-1.23	-0.27	-0.84	-0.08	-0.87	-0.42	-0.91	-0.89
September	-0.05	-0.39	-0.87	-0.49	-0.02	-1.06	-0.12	-0.78	-0.05	-0.77	-0.37	-0.55	-0.69

- Under the new CWV formula and parameters, the majority of Monthly average LDZ CWV values have decreased.
- CWVs over the summer months have consistently decreased, with the exception of NT which has increased during July and August.

Estimated change in 1 in 20 Peak Demand

- The completion of the revised CWV History has also enabled us to provide summary statistics around the 1 in 20 CWV.

- Using the same approach as described in Section 11 of NDM Algorithms Booklet, a 1 in 20 peak CWV has been calculated.

- The draft values of the 1 in 20 peak CWV has been 'inserted' into the fitted line formula (y=mx + c) for each of the 8 years used in the CWV optimisation analysis.

- Due to changes in weather sensitivity across models, the same CWV value can result in different predicted demands, which can lead to situations where a reduction in peak CWV can lead to an increase in peak demand or vice versa.

- The calculated peak demand from each of the 8 years was compared to the current basis in order to form a view of the possible impacts to peak day demand using the new formula and parameters.

Estimated change in 1 in 20 Peak Demand

LDZ	1 in 20 CWV (Current)	1 in 20 CWV (New)	Estimated % Change in Peak Day Demand
EA	-4.94	-4.66	+0.50%
EM	-6.01	-5.71	-0.04%
NE	-6.01	-5.58	+0.83%
NO	-5.62	-5.52	-0.64%
NT	-6.08	-5.63	-3.59%
NW	-6.61	-6.58	-0.36%
SC	-5.91	-5.86	-3.10%
SE	-6.44	-4.70	-2.75%
SO	-5.15	-5.16	+1.64%
SW	-4.94	-4.41	+2.47%
WM	-5.73	-7.00	+0.92%
WN	-6.61	-5.79	-2.44%
WS	-4.31	-3.33	+1.26%

- The above provides **a high level estimate** of the change in Peak Day Demand for each LDZ.
- In reality, the impact to Peak Day Demands **will only be known for each EUC in each LDZ once all of the models are re-stated on the new basis**, the new SNCWV is known and the full peak day simulations are run (expected in Q1 2020).

Conclusions – Revised CWV History

- The change in features of the revised CWV history observed here should be considered when reviewing the new Seasonal Normal profile which other than the adjusted temperature series will contain the same weather data and optimised parameters.

- The key results from the CWV optimisation process are those that display the improved relationship between CWV and Demand which has been proven in previous milestones.

- Part 2 of this presentation considers the calculation of the SNCWV .