Trial results of CWV+ definition

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Agenda

- Review results from CWV+
  - Any questions or comments on the approach – see pre-read “CWV+ Description.pdf”
  - Opportunity to consider any suggestions on the approach.
  - Does the type of information presented help DESC reach a decision for the 8th July?
  - Agreement sought for the 8th July 2019 meeting on CWV+ definition.
- Review analysis on keeping 2015 V1,V2,q parameters
  - Decision sought on 2 options
- Agree next Steps

Supporting comments since last meeting

EON

I agree that you are right to concentrate on the solar analysis. While we see rain as having an effect even within week I would rather make some changes at this update than try and get everything in and potentially miss the chance.

I suspect it is a second order effect and the lack of significant days hinders the analysis. Perhaps worth a conversation on whether optimising M-Th is the correct way to go in the future?

Npower

Thanks for the update. We agree that rainfall events that affect gas demand occur only a few times a year and agree that the focus should be on including solar. Promising to hear that this is already producing better results so we are happy that this is where the focus is.

CWV Approach

- Gas years used for deriving parameters are 2010/11 to 2017/18

- For these gas years the demand data used in CWV optimisation process is:
  - Aggregate NDM demand for LDZ. Note: All available Mon. to Thurs. non holiday demand data points used in analysis (bad NDM measurements excluded)
- For these gas years the weather data used in CWV optimisation process is:
  - Weather data from each weather station as listed in Appendix: LDZ/Weather Stations. Combination of WSSM and our weather provider history. LDZ SW is now based upon Yeovilton weather station observations.

- All gas years used to derive Pseudo SNET profile

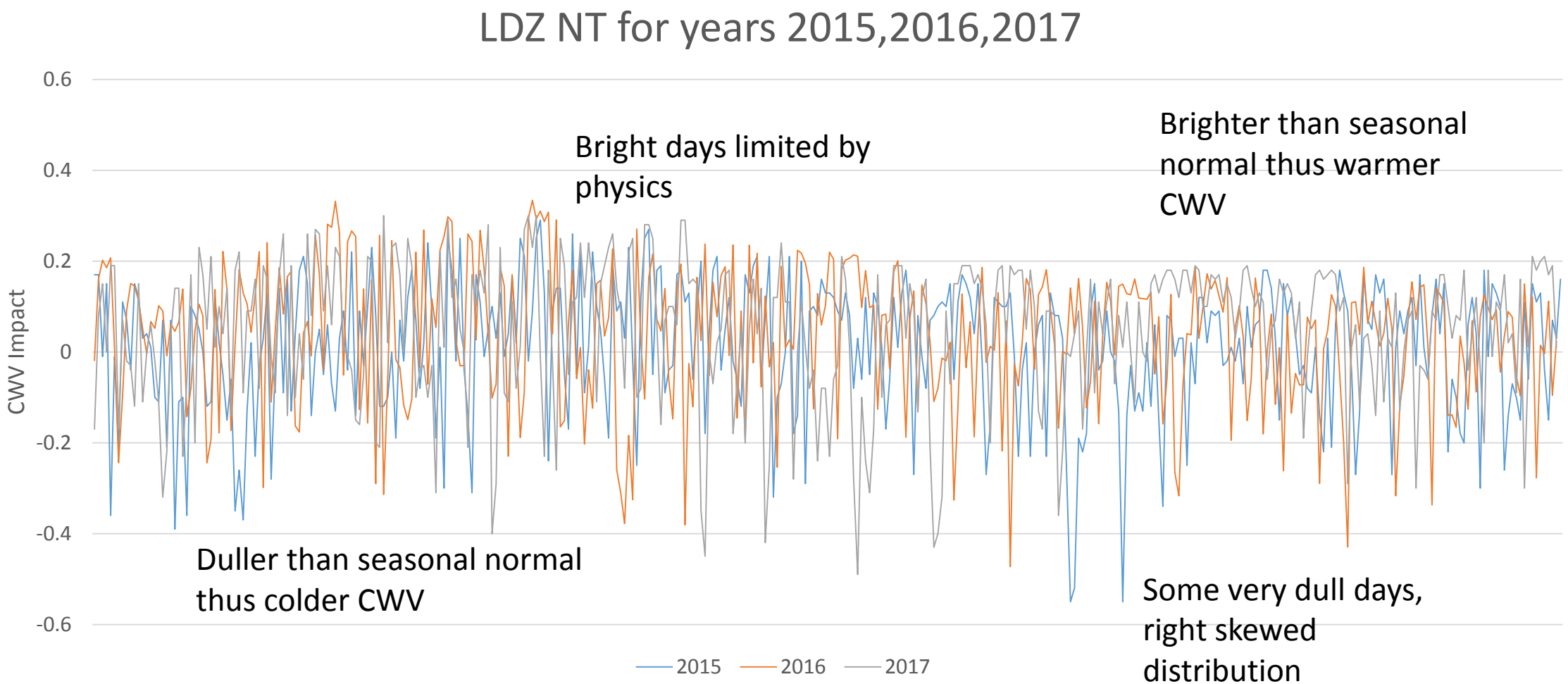
- Temperature and Wind speed weights have been updated

CWV+ Approach

- Same data and optimisation method as CWV, plus
  - Observations of solar radiance (W/m2)
  - CCM solar seasonal normal
  - Difference between obs and seasonal normal used to determine bright or dull days (variance from seasonal normal)
  - Log transformation of difference used to remove scale
  - New parameter S0 is optimised for each of the X years and the average taken as the parameter value

Full details in CWV+ Description.pdf

Solar Term impact on CWV



Use of the average of X years

- The analysis produces optimised parameters for each of the X years separately – the aim initially was to replicate the existing approach.
- The parameters across all years are then averaged which form the parameters and the results.

Pros

- Results less prone to over fitting? Or results which are initially optimised are then averaged and "un-optimised"?

Cons

- Requires an optimisation for each of the X years – time consuming.

Another option is to optimise on the total SSE across all years. It would reduce the amount of optimisation time needed by 7x. **Any comments welcome. I recommend moving to this approach for any future optimisations.**

Trade-off in results between Summer & Winter

- The results suggest a trade off in MAPE results between the summer and the winter.

- V1,V2,q determines the transition to max CWV, prominent in the summer months. The optimisation of these parameters is impacting the summer results.

Two Choices for benchmark CWV

1) Keep 2020 parameters - accept some trade-off in results across winter and summer (as measured in MAPE). As measured in R2 the models are similar.
2) Keep 2015, V1, V2, q parameters. It give a lower variance in the movement of results as measured in MAPE. As measured in R2 the models are similar.

Does DESC/TWG have a preference? I recommend 2)

Summary Results Follow

R2 Summary

LDZ	2015	2020	Same V1,V1 & q	CWV+	2020 (New Weights)
EA	0.9910	0.9909			0.9913
EM	0.9916	0.9915	0.9915	0.9921	0.9919
NE	0.9862	0.9862			0.9867
NO	0.9855	0.9844			0.9860
NT	0.9930	0.9929	0.9929	0.9937	0.9931
NW	0.9884	0.9878			0.9883
SC	0.9887	0.9886			0.9890
SE	0.9914	0.9915			0.9916
SO	0.9916	0.9908			0.9909
SW	0.9902	0.9877			0.9890
WM	0.9918	0.9922	0.9923	0.9926	0.9926
WN	0.9835	0.9843			0.9846
WS	0.9825	0.9829			0.9835

MAPE Summary

LDZ	2015	2020	Same V1,V1 & q	CWV+	2020 (New Weights)
EA	5.55	6.13			5.91
EM	6.67	6.92	6.80	6.67	6.63
NE	6.78	7.01			6.67
NO	7.27	7.42			7.24
NT	4.70	4.89	4.81	4.70	4.86
NW	6.59	6.83			6.56
SC	5.83	6.14			5.94
SE	5.20	5.44			5.62
SO	5.60	6.51			6.41
SW	5.99	6.91			6.34
WM	6.55	7.02	6.65	6.59	6.59
WN	7.39	7.25			7.17
WS	8.56	8.92			8.72

CWV+ Results

1) Improvement in R2, same MAPE
2) Detailed results include MAPE variance v benchmark

- Shoulder months much better
- December some adverse variance
- Solar explains 3-12% of error

LDZ EM: MAPE variance from 2020 Same V1,V1 & q benchmark

	MAPE VARIANCE FROM BENCHMARK								
EM	2010	2011	2012	2013	2014	2015	2016	2017	All Years
Jan	0.05%	0.08%	-0.05%	-0.05%	0.20%	0.10%	0.13%	-0.05%	0.05%
Feb	-0.10%	-0.11%	-0.14%	-0.37%	-0.15%	0.40%	-0.13%	0.09%	-0.06%
Mar	0.05%	0.67%	0.11%	0.15%	0.12%	0.27%	0.19%	0.35%	0.11%
Apr	-0.86%	-0.31%	-0.24%	-0.66%	-0.83%	-0.06%	-0.64%	-0.87%	-0.56%
May	-0.68%	-0.32%	-1.33%	-0.41%	-0.12%	-0.31%	-0.54%	-0.95%	-0.58%
Jun	0.00%	0.00%	-0.80%	0.18%	0.45%	-0.55%	-0.11%	-0.16%	-0.12%
Jul	-0.12%	-0.78%	0.01%	0.28%	-0.22%	0.48%	0.00%	0.12%	-0.03%
Aug	-0.62%	-0.03%	-0.06%	-0.07%	-0.47%	0.66%	-0.41%	-0.01%	-0.13%
Sep	-0.08%	0.40%	0.25%	-0.12%	-0.40%	0.24%	-0.08%	-0.19%	0.00%
Oct	-0.44%	-0.62%	-0.63%	0.15%	0.26%	-0.66%	-0.07%	-0.28%	-0.29%
Nov	-0.15%	-0.05%	-0.12%	-0.03%	-0.03%	-0.15%	-0.13%	-0.17%	-0.06%
Dec	0.11%	0.11%	0.37%	0.22%	-0.17%	-0.05%	-0.06%	0.37%	0.11%
All Month	-0.19%	-0.19%	-0.22%	-0.09%	-0.09%	-0.01%	-0.16%	-0.15%	-0.14%

Do the Detailed LDZ Results presented allow DESC to make a decision in the next meeting?
The intention at next the DESC meeting is to provide more LDZ results as currently presented plus anything new following this review.

CWV+ Next steps

Chance for DESC/TWG to feedback on the proposed definition.

Agreement sought for the 8th July 2019 meeting.

Options:

- Continue with more LDZ results in proposed form
- Consider alternative definitions

Detailed LDZ Results Follow

Four Sets of Results

1. Optimisation based upon the 2015 parameters
2. 13th May Meeting Benchmark Results – 2020 parameters
3. Results from 2) but keeping 2015 V1,V2,q parameters
4. 2020 CWV+ results – comparable 3) to highlight improvement only due to solar.

Results: LDZ EM

Parameter	2015	2020	V1,V2,q	CWV+
Effective Temperature/AT Weight	0.500	0.476	0.476	0.476
Effective Temperature Weight (I1)	0.691	0.679	0.679	0.679
Wind Chill Weight (I2)	0.0144	0.014	0.014	0.014
Cold Weather Sensitivity (I3)	0.05	0.189	0.189	0.189
Cold Weather Upturn Threshold (V0)	3	1.436	1.436	1.436
Lower Warm Weather Cut-Off (V1)	13.5	13.136	13.5	13.5
Upper Warm Weather Cut-Off (V2)	16.8	17.676	16.8	16.8
Slope Relating to Warm Weather Cut-Off (q)	0.49	0.454	0.49	0.49
Wind Chill Wind Cut-Off (W0)	0	1.538	1.538	1.538
Wind Chill Temperature Cut-Off (T0)	14	14.516	14.516	14.516
Solar Radiance Effect (S0)	-			0.556
R2	**0.9916**	**0.9915**	**0.9915**	**0.9921**

CWV Optimisation

LDZ	Station
EM	Watnall (Nottingham)

Gas Years	2010/11 to 2017/18

Parameters	Avg. Mean Abs. %Error
2015	6.67%
2020	6.92%

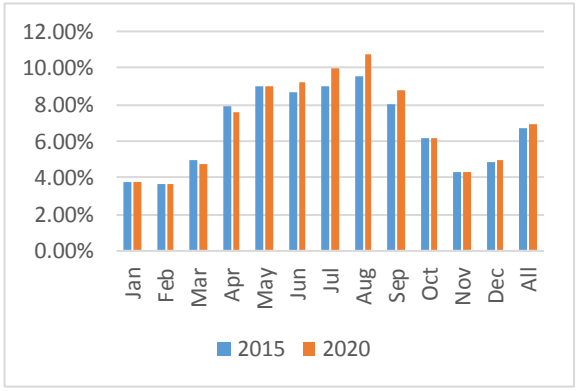
Avg. Adj. R-Sq.	Avg. RMSE (MWhs)	Avg. %diff. in est 1 in20 peak demand
0.9916	9060	
0.9915	9153	

1. 13th May Meeting Benchmark Results - CWV Optimisation 2015 compared with 2020

MAPE

Month	2015	2020
Jan	3.78%	3.77%
Feb	3.61%	3.60%
Mar	4.93%	4.78%
Apr	7.91%	7.58%
May	8.98%	9.02%
Jun	8.66%	9.19%
Jul	9.06%	9.99%
Aug	9.57%	10.76%
Sep	8.04%	8.74%
Oct	6.11%	6.14%
Nov	4.33%	4.30%
Dec	4.83%	4.92%
All	6.67%	6.92%

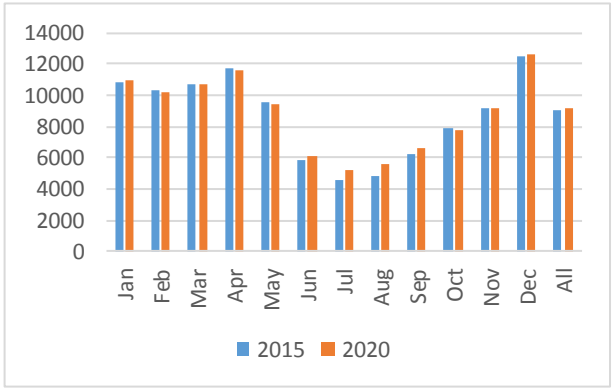
Season				
Year	Dec - Feb	Mar - May	Jun-Aug	Sep- Nov
2015	4.09%	7.27%	9.10%	6.16%
2020	4.11%	7.12%	9.99%	6.39%



RMSE

Month	2015	2020
Jan	10835	10968
Feb	10316	10233
Mar	10744	10738
Apr	11739	11549
May	9518	9473
Jun	5817	6050
Jul	4541	5140
Aug	4832	5633
Sep	6284	6592
Oct	7891	7799
Nov	9143	9177
Dec	12470	12629
All	9060	9153

Season				
Year	Dec - Feb	Mar - May	Jun-Aug	Sep- Nov
2015	11299	10694	5084	7842
2020	11394	10610	5615	7926



Keeping 2015 V1,V2,q parameters

LDZ	Station
EM	all (Nottingham)

Gas Years	2010/11 to 2017/18

Results from 1) but keeping 2015 V1,V2,q parameters

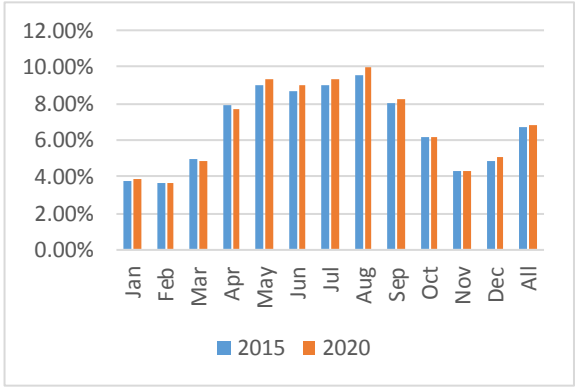
Parameters	Avg. Mean Abs. %Error
2015	6.67%
2020	6.80%

Avg. Adj. R-Sq.	Avg. RMSE (MWhs)	Avg. %diff. in est 1 in20 peak demand
0.9916	9060	
0.9915	9183	

MAPE

Month	2015	2020
Jan	3.78%	3.82%
Feb	3.61%	3.69%
Mar	4.93%	4.83%
Apr	7.91%	7.74%
May	8.98%	9.36%
Jun	8.66%	8.97%
Jul	9.06%	9.33%
Aug	9.57%	9.94%
Sep	8.04%	8.29%
Oct	6.11%	6.11%
Nov	4.33%	4.30%
Dec	4.83%	5.03%
All	6.67%	6.80%

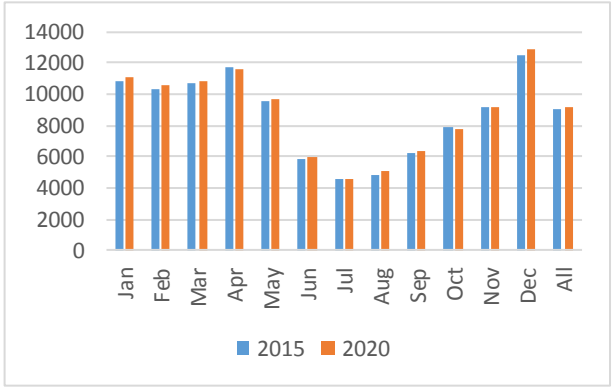
Season				
Year	Dec - Feb	Mar - May	Jun-Aug	Sep- Nov
2015	4.09%	7.27%	9.10%	6.16%
2020	4.20%	7.30%	9.42%	6.23%



RMSE

Month	2015	2020
Jan	10835	11039
Feb	10316	10510
Mar	10744	10862
Apr	11739	11631
May	9518	9720
Jun	5817	5935
Jul	4541	4618
Aug	4832	5131
Sep	6284	6373
Oct	7891	7737
Nov	9143	9180
Dec	12470	12864
All	9060	9183

Season				
Year	Dec - Feb	Mar - May	Jun-Aug	Sep- Nov
2015	11299	10694	5084	7822
2020	11580	10757	5248	7846



2020 CWV+

LDZ	Station
EM	Watnall (Nottingham)

Gas Years	2010/11 to 2017/18

2020 CWV+ results – comparable 2) to highlight improvement due to solar.

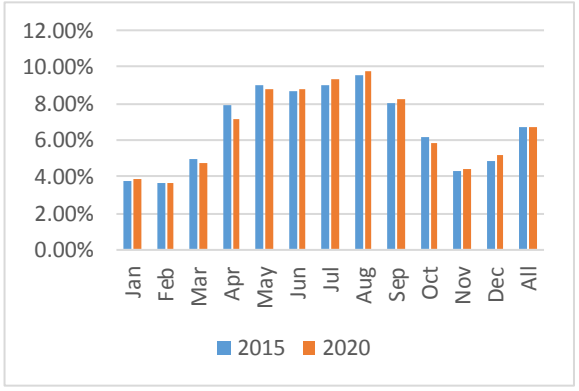
Parameters	Avg. Mean Abs. %Error
2015	6.67%
2020	6.67%

Avg. Adj. R-Sq.	Avg. RMSE (MWhs)	Avg. %diff. in est 1 in20 peak demand
0.9916	9060	
0.9921	9021	

MAPE

Month	2015	2020
Jan	3.78%	3.87%
Feb	3.61%	3.63%
Mar	4.93%	4.72%
Apr	7.91%	7.18%
May	8.98%	8.78%
Jun	8.66%	8.84%
Jul	9.06%	9.30%
Aug	9.57%	9.82%
Sep	8.04%	8.30%
Oct	6.11%	5.83%
Nov	4.33%	4.36%
Dec	4.83%	5.14%
All	6.67%	6.67%

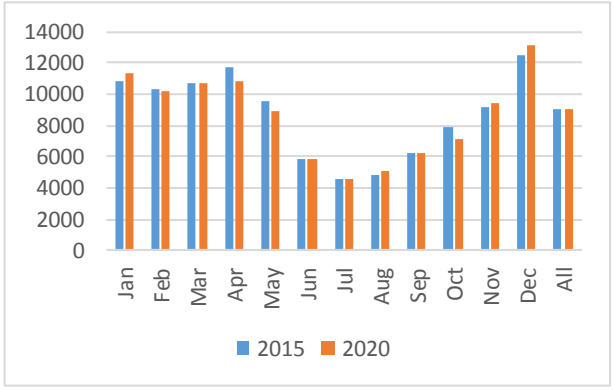
Season				
Year	Dec - Feb	Mar - May	Jun-Aug	Sep- Nov
2015	4.09%	7.27%	9.10%	6.16%
2020	4.23%	6.89%	9.32%	6.16%



RMSE

Month	2015	2020
Jan	10835	11350
Feb	10316	10231
Mar	10744	10658
Apr	11739	10819
May	9518	8901
Jun	5817	5807
Jul	4541	4580
Aug	4832	5038
Sep	6284	6256
Oct	7891	7180
Nov	9143	9458
Dec	12470	13179
All	9060	9021

Season				
Year	Dec - Feb	Mar - May	Jun-Aug	Sep- Nov
2015	11299	10694	5084	7750
2020	11731	10156	5159	7743



2020 CWV+ variance v CWV benchmark

	MAPE VARIANCE FROM BENCHMARK								
EM	2010	2011	2012	2013	2014	2015	2016	2017	All Years
Jan	0.05%	0.08%	-0.05%	-0.05%	0.20%	0.10%	0.13%	-0.05%	0.05%
Feb	-0.10%	-0.11%	-0.14%	-0.37%	-0.15%	0.40%	-0.13%	0.09%	-0.06%
Mar									
Apr	-0.86%	-0.31%	-0.24%	-0.66%	-0.83%	-0.06%	-0.64%	-0.87%	-0.56%
May	-0.68%	-0.32%	-1.33%	-0.41%	-0.12%	-0.31%	-0.54%	-0.95%	-0.58%
Jun									
Jul	-0.12%	-0.78%	0.01%	0.28%	-0.22%	0.48%	0.00%	0.12%	-0.03%
Aug	-0.62%	-0.03%	-0.06%	-0.07%	-0.47%	0.66%	-0.41%	-0.01%	-0.13%
Sep									
Oct	-0.44%	-0.62%	-0.63%	0.15%	0.26%	-0.66%	-0.07%	-0.28%	-0.29%
Nov	0.45%	-0.05%			0.23%	-0.15%	0.13%		0.06%
Dec	0.11%	0.11%	0.37%	0.22%	-0.17%	-0.05%	-0.06%	0.37%	
All Month	-0.19%	-0.19%	-0.22%	-0.09%	-0.09%	-0.01%	-0.16%	-0.15%	-0.14%

Solar effect

Results: LDZ NT

Parameter	2015	2020	V1,V2,q	CWV+
Effective Temperature/AT Weight	0.500	0.471	0.471	0.471
Effective Temperature Weight (I1)	0.727	0.730	0.730	0.730
Wind Chill Weight (I2)	0.0151	0.015	0.015	0.015
Cold Weather Sensitivity (I3)	0.22	0.345	0.345	0.345
Cold Weather Upturn Threshold (V0)	3	2.130	2.130	2.130
Lower Warm Weather Cut-Off (V1)	15.2	14.719	15.2	15.2
Upper Warm Weather Cut-Off (V2)	19.2	19.444	19.2	19.2
Slope Relating to Warm Weather Cut-Off (q)	0.38	0.438	0.38	0.38
Wind Chill Wind Cut-Off (W0)	0	-1.157	-1.157	-1.157
Wind Chill Temperature Cut-Off (T0)	14	13.537	13.537	13.537
Solar Radiance Effect (S0)	-			0.689
R2	**0.9930**	**0.9929**	**0.9929**	**0.9937**

CWV Optimisation

LDZ	Station
NT	Heathrow

Gas Years	2010/11 to 2017/18

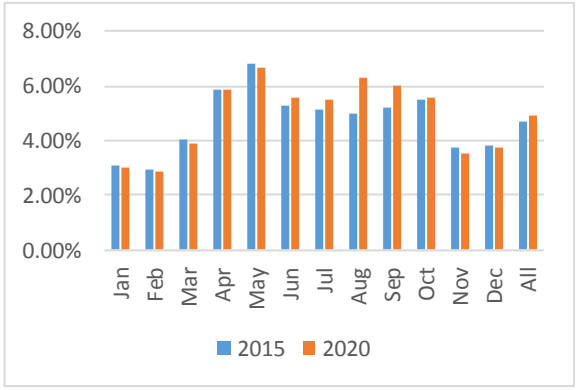
Parameters	Avg. Mean Abs. %Error
2015	4.70%
2020	4.89%

Avg. Adj. R-Sq.	Avg. RMSE (MWhs)	Avg. %diff. in est 1 in20 peak demand
0.9930	7748	
0.9929	7738	

MAPE

Month	2015	2020
Jan	3.07%	3.03%
Feb	2.92%	2.84%
Mar	4.04%	3.91%
Apr	5.87%	5.89%
May	6.79%	6.66%
Jun	5.26%	5.58%
Jul	5.11%	5.49%
Aug	4.99%	6.30%
Sep	5.17%	5.97%
Oct	5.52%	5.58%
Nov	3.76%	3.56%
Dec	3.82%	3.74%
All	4.70%	4.89%

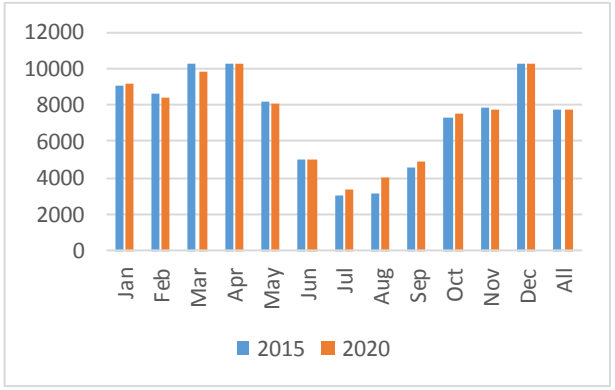
	Season			
Year	Dec - Feb	Mar - May	Jun-Aug	Sep- Nov
2015	3.28%	5.56%	5.12%	4.82%
2020	3.22%	5.48%	5.79%	5.04%



RMSE

Month	2015	2020
Jan	9072	9193
Feb	8569	8399
Mar	10281	9880
Apr	10238	10228
May	8205	8025
Jun	4993	4969
Jul	3059	3362
Aug	3104	4018
Sep	4550	4923
Oct	7360	7488
Nov	7882	7734
Dec	10308	10236
All	7748	7738

	Season			
Year	Dec - Feb	Mar - May	Jun-Aug	Sep- Nov
2015	9483	9616	3811	6756
2020	9478	9419	4160	6842



Keeping 2015 V1,V2,q parameters

LDZ	Station
NT	Heathrow

Gas Years	2010/11 to 2017/18

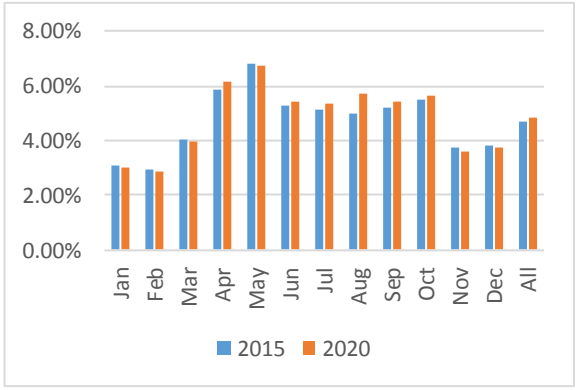
Parameters	Avg. Mean Abs. %Error
2015	4.70%
2020	4.81%

Avg. Adj. R-Sq.	Avg. RMSE (MWhs)	Avg. %diff. in est 1 in20 peak demand
0.9930	7748	
0.9929	7725	

MAPE

Month	2015	2020
Jan	3.07%	3.02%
Feb	2.92%	2.85%
Mar	4.04%	3.93%
Apr	5.87%	6.14%
May	6.79%	6.77%
Jun	5.26%	5.39%
Jul	5.11%	5.38%
Aug	4.99%	5.71%
Sep	5.17%	5.41%
Oct	5.52%	5.64%
Nov	3.76%	3.56%
Dec	3.82%	3.73%
All	4.70%	4.81%

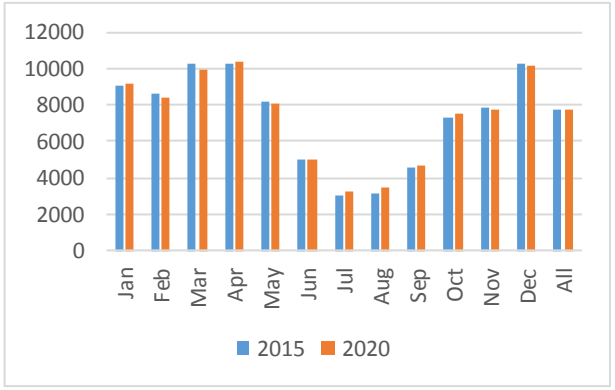
Season				
Year	Dec - Feb	Mar - May	Jun-Aug	Sep- Nov
2015	3.28%	5.56%	5.12%	4.82%
2020	3.21%	5.61%	5.50%	4.88%



RMSE

Month	2015	2020
Jan	9072	9130
Feb	8569	8441
Mar	10281	9902
Apr	10238	10406
May	8205	8070
Jun	4993	5045
Jul	3059	3222
Aug	3104	3524
Sep	4550	4703
Oct	7360	7534
Nov	7882	7697
Dec	10308	10194
All	7748	7725

Season				
Year	Dec - Feb	Mar - May	Jun-Aug	Sep- Nov
2015	9483	9616	3811	6760
2020	9452	9503	3998	6794



2020 CWV+

LDZ	Station
NT	Heathrow

Gas Years	2010/11 to 2017/18

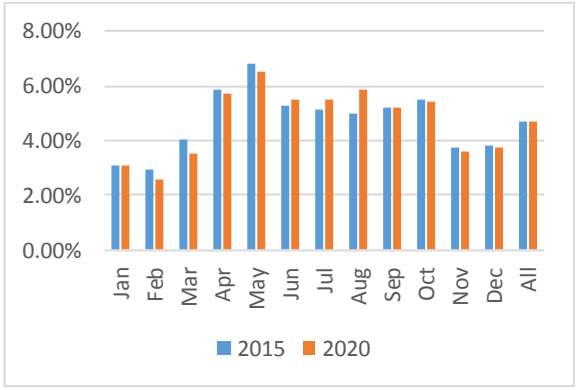
Parameters	Avg. Mean Abs. %Error
2015	4.70%
2020	4.70%

Avg. Adj. R-Sq.	Avg. RMSE (MWhs)	Avg. %diff. in est 1 in20 peak demand
0.9930	7748	
0.9937	7410	

MAPE

Month	2015	2020
Jan	3.07%	3.09%
Feb	2.92%	2.60%
Mar	4.04%	3.51%
Apr	5.87%	5.68%
May	6.79%	6.55%
Jun	5.26%	5.52%
Jul	5.11%	5.51%
Aug	4.99%	5.85%
Sep	5.17%	5.19%
Oct	5.52%	5.39%
Nov	3.76%	3.59%
Dec	3.82%	3.71%
All	4.70%	4.70%

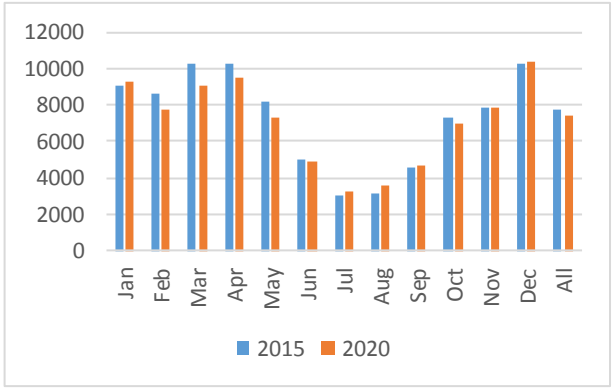
Season				
Year	Dec - Feb	Mar - May	Jun-Aug	Sep- Nov
2015	3.28%	5.56%	5.12%	4.82%
2020	3.15%	5.24%	5.63%	4.73%



RMSE

Month	2015	2020
Jan	9072	9333
Feb	8569	7690
Mar	10281	9012
Apr	10238	9502
May	8205	7335
Jun	4993	4894
Jul	3059	3284
Aug	3104	3553
Sep	4550	4645
Oct	7360	6973
Nov	7882	7876
Dec	10308	10366
All	7748	7410

Season				
Year	Dec - Feb	Mar - May	Jun-Aug	Sep- Nov
2015	9483	9616	3811	6621
2020	9390	8657	3962	6643



2020 CWV+ variance v CWV benchmark

	MAPE VARIANCE FROM BENCHMARK								
NT	2010	2011	2012	2013	2014	2015	2016	2017	All Years
Jan	-0.13%	-0.03%	-0.02%	0.07%	0.26%	0.09%	0.12%	0.19%	0.07%
Feb	0.00%	-0.36%	-0.31%	-0.70%	-0.29%	0.04%	-0.29%	-0.09%	-0.25%
Mar	-0.37%	-0.61%	-0.64%	-0.74%	-0.45%	-0.31%	-0.33%	0.09%	-0.42%
Apr	-0.15%	-0.51%	-0.40%	-0.19%	-0.48%	-0.47%	-0.85%	-0.68%	-0.47%
May	-0.29%	-0.71%	-0.76%	-0.07%	0.47%	-0.47%	-0.11%	0.18%	-0.22%
Jun	0.47%	-0.37%	0.14%	0.55%	0.23%	-0.49%	0.42%	0.09%	0.13%
Jul	0.28%	-0.21%	0.20%	-0.04%	0.50%	-0.17%	0.18%	0.34%	0.13%
Aug	0.22%	-0.39%	0.03%	-0.39%	0.64%	0.15%	0.17%	0.60%	0.13%
Sep	-0.16%	-0.90%	-0.18%	-0.32%	0.06%	-0.25%	0.06%	0.00%	-0.21%
Oct	-0.42%	-0.39%	-0.24%	-0.17%	0.77%	-0.80%	-0.25%	-0.50%	-0.25%
Nov	0.15%	0.03%	0.03%	-0.01%	0.06%	-0.32%	0.21%	0.07%	0.03%
Dec	0.08%	0.06%	-0.05%	-0.01%	-0.53%	0.06%	-0.14%	0.37%	-0.02%
All Month	-0.03%	-0.37%	-0.18%	-0.17%	0.10%	-0.25%	-0.07%	0.05%	-0.11%

Results: LDZ WM

Parameter	2015	2020	V1,V2,q	CWV+
Effective Temperature/AT Weight	0.500	0.467	0.467	0.467
Effective Temperature Weight (I1)	0.72	0.692	0.692	0.692
Wind Chill Weight (I2)	0.0111	0.012	0.012	0.012
Cold Weather Sensitivity (I3)	0.14	0.242	0.242	0.242
Cold Weather Upturn Threshold (V0)	3	2.264	2.264	2.264
Lower Warm Weather Cut-Off (V1)	13.7	13.367	13.7	13.7
Upper Warm Weather Cut-Off (V2)	17.2	18.292	17.2	17.2
Slope Relating to Warm Weather Cut-Off (q)	0.43	0.424	0.43	0.43
Wind Chill Wind Cut-Off (W0)	0	0.186	0.186	0.186
Wind Chill Temperature Cut-Off (T0)	14	16.029	16.029	16.029
Solar Radiance Effect (S0)				0.508
R2	**0.9918**	**0.9922**	**0.9923**	**0.9926**

CWV Optimisation

LDZ	Station
WM	Winterbourne

Gas Years	2010/11 to 2017/18

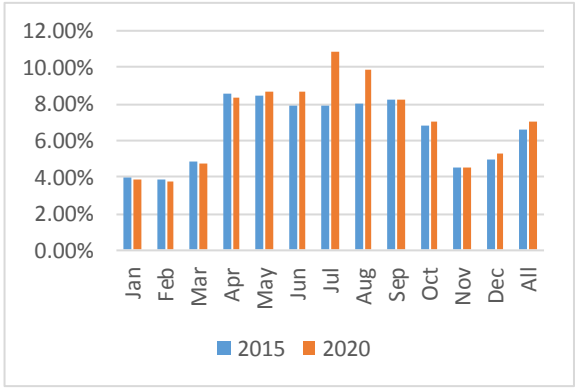
Parameters	Avg. Mean Abs. %Error
2015	6.55%
2020	7.02%

Avg. Adj. R-Sq.	Avg. RMSE (MWhs)	Avg. %diff. in est 1 in20 peak demand
0.9918	8155	
0.9922	8221	

MAPE

Month	2015	2020
Jan	4.01%	3.91%
Feb	3.90%	3.78%
Mar	4.88%	4.69%
Apr	8.57%	8.39%
May	8.48%	8.65%
Jun	7.95%	8.66%
Jul	7.96%	10.92%
Aug	8.02%	9.93%
Sep	8.24%	8.22%
Oct	6.86%	7.04%
Nov	4.57%	4.53%
Dec	4.96%	5.29%
All	6.55%	7.02%

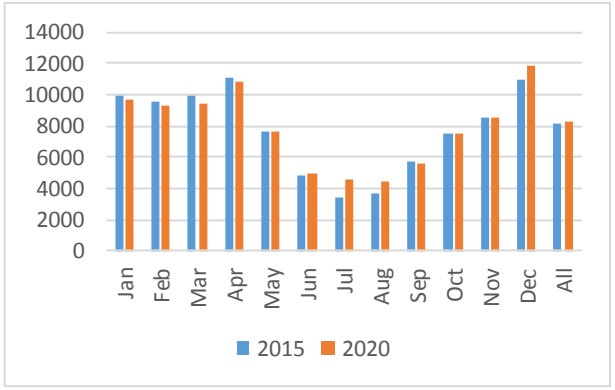
Season				
Year	Dec - Feb	Mar - May	Jun-Aug	Sep- Nov
2015	4.30%	7.29%	7.98%	6.56%
2020	4.34%	7.23%	9.85%	6.60%



RMSE

Month	2015	2020
Jan	9870	9726
Feb	9533	9333
Mar	9882	9446
Apr	11130	10786
May	7659	7647
Jun	4861	4954
Jul	3452	4560
Aug	3642	4462
Sep	5746	5582
Oct	7556	7479
Nov	8514	8555
Dec	10956	11871
All	8155	8221

Season				
Year	Dec - Feb	Mar - May	Jun-Aug	Sep- Nov
2015	10198	9647	4024	7353
2020	10429	9365	4660	7312



Keeping 2015 V1,V2,q parameters

LDZ	Station
WM	Winterbourne

Gas Years	2010/11 to 2017/18

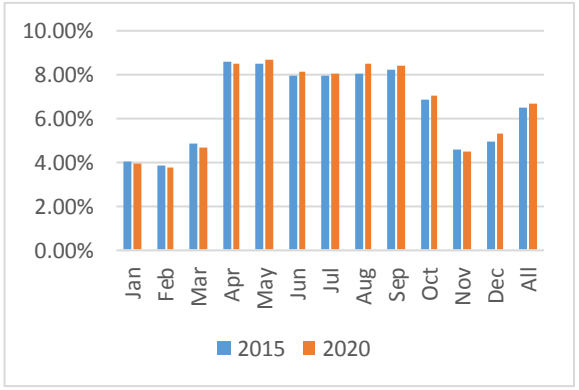
Parameters	Avg. Mean Abs. %Error
2015	6.55%
2020	6.65%

Avg. Adj. R-Sq.	Avg. RMSE (MWhs)	Avg. %diff. in est 1 in20 peak demand
0.9918	8155	
0.9923	8186	

MAPE

Month	2015	2020
Jan	4.01%	3.91%
Feb	3.90%	3.79%
Mar	4.88%	4.72%
Apr	8.57%	8.52%
May	8.48%	8.68%
Jun	7.95%	8.15%
Jul	7.96%	8.06%
Aug	8.02%	8.51%
Sep	8.24%	8.44%
Oct	6.86%	7.00%
Nov	4.57%	4.52%
Dec	4.96%	5.31%
All	6.55%	6.65%

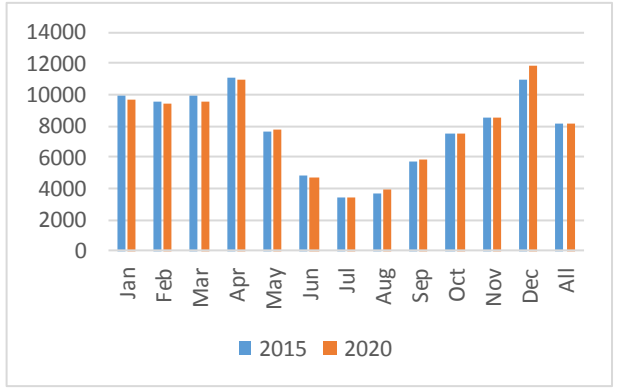
Season				
Year	Dec - Feb	Mar - May	Jun-Aug	Sep- Nov
2015	4.30%	7.29%	7.98%	6.56%
2020	4.36%	7.29%	8.24%	6.66%



RMSE

Month	2015	2020
Jan	9870	9731
Feb	9533	9414
Mar	9882	9505
Apr	11130	10916
May	7659	7695
Jun	4861	4698
Jul	3452	3466
Aug	3642	3928
Sep	5746	5793
Oct	7556	7531
Nov	8514	8551
Dec	10956	11857
All	8155	8186

Season				
Year	Dec - Feb	Mar - May	Jun-Aug	Sep- Nov
2015	10198	9647	4024	7370
2020	10448	9447	4055	7382



2020 CWV+

LDZ	Station
WM	Winterbourne

Gas Years	2010/11 to 2017/18

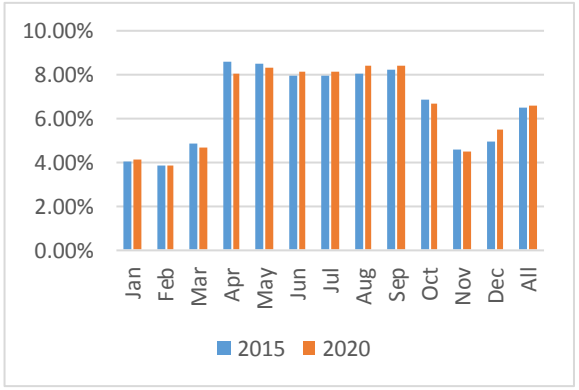
Parameters	Avg. Mean Abs. %Error
2015	6.55%
2020	6.59%

Avg. Adj. R-Sq.	Avg. RMSE (MWhs)	Avg. %diff. in est 1 in20 peak demand
0.9918	8155	
0.9926	8136	

MAPE

Month	2015	2020
Jan	4.01%	4.10%
Feb	3.90%	3.86%
Mar	4.88%	4.64%
Apr	8.57%	8.10%
May	8.48%	8.34%
Jun	7.95%	8.12%
Jul	7.96%	8.15%
Aug	8.02%	8.44%
Sep	8.24%	8.46%
Oct	6.86%	6.71%
Nov	4.57%	4.50%
Dec	4.96%	5.53%
All	6.55%	6.59%

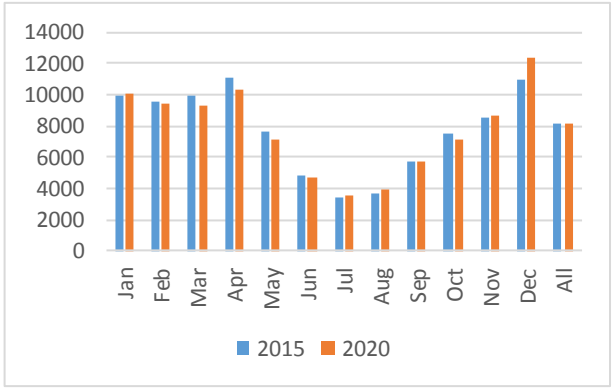
Season				
Year	Dec - Feb	Mar - May	Jun-Aug	Sep- Nov
2015	4.30%	7.29%	7.98%	6.56%
2020	4.52%	7.01%	8.24%	6.56%



RMSE

Month	2015	2020
Jan	9870	10105
Feb	9533	9390
Mar	9882	9330
Apr	11130	10373
May	7659	7173
Jun	4861	4665
Jul	3452	3493
Aug	3642	3891
Sep	5746	5687
Oct	7556	7141
Nov	8514	8650
Dec	10956	12323
All	8155	8136

Season				
Year	Dec - Feb	Mar - May	Jun-Aug	Sep- Nov
2015	10198	9647	4024	7275
2020	10739	9042	4039	7260



2020 CWV+ variance v CWV benchmark

	MAPE VARIANCE FROM BENCHMARK								
WM	2010	2011	2012	2013	2014	2015	2016	2017	All Years
Jan	-0.01%	0.05%	0.19%	0.10%	0.31%	0.35%	0.24%	0.23%	0.18%
Feb	0.08%	-0.06%	0.13%	-0.18%	0.04%	0.34%	0.18%	0.04%	0.07%
Mar	0.14%	-0.15%	-0.23%	-0.54%	0.22%	-0.05%	-0.32%	0.29%	-0.08%
Apr	-0.42%	-0.29%	-0.21%	-0.52%	-0.70%	-0.18%	-0.74%	-0.33%	-0.42%
May	-0.36%	-0.12%	-1.20%	-0.06%	-0.03%	-0.63%	-0.33%	0.03%	-0.34%
Jun	-0.04%	0.28%	-0.05%	0.25%	0.22%	-0.04%	0.07%	-0.27%	-0.02%
Jul	-0.28%	-0.20%	0.00%	0.39%	0.23%	0.42%	-0.08%	0.21%	0.09%
Aug	-0.46%	0.17%	0.32%	-0.34%	-0.66%	0.39%	-0.46%	0.46%	-0.07%
Sep	-0.15%	0.37%	0.42%	-0.45%	-0.60%	0.40%	0.11%	0.03%	0.02%
Oct	-0.11%	-0.50%	-0.56%	0.06%	0.36%	-0.78%	-0.39%	-0.42%	-0.29%
Nov	0.23%	-0.19%	0.09%	-0.32%	0.23%	-0.46%	0.16%	0.05%	-0.03%
Dec	0.16%	0.36%	0.32%	0.20%	-0.25%	0.35%	0.07%	0.53%	0.22%
All Month	-0.10%	-0.02%	-0.12%	-0.12%	-0.05%	0.01%	-0.12%	0.07%	-0.06%

General comments on optimisation

- Optimisation attempts to find the best set of parameters that produces the highest model fit as measured by minimizing SSE for each of the X years.
- Given the range of parameters to be optimised and the scale of the computations it not possible to search all possible values to find a “global minimum”, therefore many of the results are likely to be “local minimums”.
- It’s a feature of the current approach and the 2015 parameters would also be affected by the issue.

Parameter Interpretations

Parameter	Interpretations
Effective Temperature/AT Weight (ET calculation)	Determines the combination of AT/ET used in the SNET calculation and how much of yesterday ET is used for todays ET
Effective Temperature Weight (I1)	What proportion of SNET is included in SNET Term (≈0.3)
Wind Chill Weight (I2)	In combination with W0 & T0 calculates WCT – gives a colder CWV where AT is less than T0
Cold Weather Sensitivity (I3)	CWV Cold: Determines when cold weather upturn is applied.
Cold Weather Upturn Threshold (V0)	
Lower Warm Weather Cut-Off (V1)	CWV Transition : Attempts to model a lower demand response as temperature increase. These in combination determines Max CWV
Upper Warm Weather Cut-Off (V2)	
Slope Relating to Warm Weather Cut-Off (q)	
Wind Chill Wind Cut-Off (W0)	determines at what speed wind (DWS) produces a wind chill effect
Wind Chill Temperature Cut-Off (T0)	values of temperature (AT) when wind chill is applied
Solar Radiance Effect (S0)	Solar effect on demand

LDZ/Weather Stations

LDZ	Weather Station
EA	Heathrow
EM	Watnall (Nottingham)
NE	Watnall (Nottingham)
NO	Albemarle
NT	Heathrow
NW	Manchester Rostherne
SC	Glasgow Bishopton
SE	Heathrow
SO	Southampton Oceanographic Centre
SW	Yeovilton (from Filton)
WM	Winterbourne/Coleshill (Birmingham)
WN	Manchester Rostherne
WS	St Athan

Weather data history was complete in most LDZs, requiring minimal cleaning/filling, except for:

WM – use of Coleshill temperatures for the period 01/10/2010-28/02/2011 due to missing Winterbourne station data