

NDM Algorithm Performance:

Strand 3 – NDM Demand Analysis

(Gas Year 2020/21)

Demand Estimation Sub Committee
14/12/2021

The logo for Xserve, featuring a stylized 'X' composed of blue and light blue geometric shapes followed by the word 'serve' in a light blue sans-serif font.

Provided by:

The logo for Correla, consisting of two overlapping circles, one blue and one yellow, followed by the word 'correla' in a dark blue sans-serif font.

Content

- Objective, Approach and Considerations
- NDM Daily Demand Analysis
 - Selected EUC Results:
01BND, 01BPD, 01BNI, 04B & 06B
 - Summary of All EUC Results
- Conclusions



Strand 3 – NDM Daily Demand Analysis

Objective, Approach and Considerations

Strand 3: NDM Daily Demand Analysis

Background:

- An evaluation of the NDM Supply Meter Point Demand formula by comparing actual daily demands for NDM supply meter points with estimates of their daily demands across the range of EUCs

Objective:

- Assess accuracy of the algorithms for Gas Year 2020/21
- Identify possible areas of improvement for future demand modelling

Note:

- Assessment is made on supply meter points which comprise the Demand Estimation Sample including data provided by shippers

Strand 3: Approach

Analysis has taken the following approach:

- Daily NDM consumption data obtained for Gas Year 2020/21
- Validation applied to all daily NDM consumption data in order to exclude sites with suspicious or erroneous data
- Calculate the Model Error:
Mean Absolute Percent Error (MAPE) – ‘overall error’ and Mean Percentage Error (MPE) – ‘overall bias’
 - **MODEL:** Allocated using
 - NDM sample derived AQs
 - 2020/21 ALPs and DAFs and
 - 2020/21 Weather Correction Factors (WCF)
 - **RETRO:** Allocated using
 - NDM sample derived AQs
 - 2021/22 ALPs and DAFs (adjusted to day/holiday pattern in 2020/21) and
 - 2020/21 Weather Correction Factors (WCF)
- Assessments conducted by EUC (bucket bands only) for all LDZs for full year, Summer/Winter and by month

Strand 3: Modelling Error Analysis

- The analysis is based on an assessment of the percentage errors performed for each EUC 'bucket' band (weighted average across all LDZs) against
 - Each of the three bases for Winter, Summer and Full Year
 - Monthly
- Mean Absolute Percentage Error (MAPE) is a measure of prediction accuracy of a forecasting method
 - It is calculated as $\text{Absolute}(\text{Actual Energy} - \text{Model Energy}) / \text{Actual Energy}$
 - The lower the MAPE value, the closer the prediction was to the actual value. For example, a MAPE of 3% means that, on average, the forecast is out by 3%.
- Mean Percentage Error (MPE) is a measure of the bias in the forecasting method
 - It is calculated as $(\text{Actual Energy} - \text{Model Energy}) / \text{Actual Energy}$
 - Where Actual Energy > Model Energy the models have under allocated, e.g. if MPE is 2% the model has under allocated by 2%
 - Where Actual Energy < Model Energy the models have over allocated e.g. if MPE is -2% the model has over allocated by 2%

Strand 3: Source Data - Summary

Daily NDM consumption data for Gas Year 2020/21 was available from the following four sources:

- Xoserve Managed; Network Managed & Third Party Provided (i.e. Shippers)
- In addition, this year we also explored the Class 3 data available to see if we could supplement the limited PPM data that was received
 - We retrieved daily gas consumption data for supply meter points with an EUC of "01BPD". These sites will have been assigned this EUC due to its Meter Mechanism and Payment Method (alongside Market Sector Code). The assumption is these data items continue to be correct in UK Link. By default, these will all be SMART meters in Pre-payment mode as Legacy PPMs cannot record daily consumption

Validation excludes Supply Meter Points which are deemed not usable

- For example: Insufficient data points; excessive consecutive zero consumption; excessive or negative consumption; suspicious day of the week profile; obvious Market Sector Flag inaccuracies
- Sites with erroneous data may slip through and will affect the perceived results

Table below summarises the Supply Meter Point counts:

Source	Xoserve Managed	Network Managed	3rd Party Provided	Class 3 Data (PPM)
Initial SP Count of Available Data	2,141	8,979	28,860	6,480
Final SP Count of Usable Data	1,598	6,137	16,597	3,481
% Deemed Usable	75%	68%	58%	54%

Strand 3: Source Data – Breakdown

	SC	NO	NW	NE	EM	WM	WN	WS	EA	NT	SE	SO	SW	Total Supply Points	% Non - Third Party	% Third Party
01BND	267	275	304	283	280	308	121	280	279	308	302	291	281	3,579	32.61%	67.39%
01BNI	782	450	636	398	346	367	49	196	398	382	486	277	382	5,149	6.41%	93.59%
01BPD	41	408	880	449	179	394	250	271	224	209	15	271	379	3,970	87.66%	12.34%
02BND	14	5	13	12	12	10	0	3	6	7	9	10	12	113	89.38%	10.62%
02BNI	1,049	371	790	425	715	701	62	195	459	583	609	500	481	6,940	14.01%	85.99%
03B	754	149	215	169	216	181	35	53	205	228	298	214	152	2,869	41.65%	58.35%
04B	492	178	217	259	183	212	30	86	217	228	358	259	151	2,870	67.11%	32.89%
05B	200	84	90	106	75	100	12	29	61	99	118	90	47	1,111	82.00%	18.00%
06B	62	34	31	42	49	36	6	15	20	21	32	41	27	416	92.79%	7.21%
07B	22	13	11	19	27	19	0	4	7	5	11	14	7	159	96.23%	3.77%
08B	8	5	2	4	11	8	0	3	4	7	8	4	6	70	94.29%	5.71%
09B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%	0.00%
Totals	3,691	1,972	3,189	2,166	2,093	2,336	565	1,135	1,880	2,077	2,246	1,971	1,925	27,246		

- Table shows breakdown of validated sample sites used in analysis
- Good numbers overall, but some EUC & LDZ combinations contain either no sample data (therefore no analysis is possible) or very few validated sample points (which can skew the results significantly)
- Analysis has not been performed for Band 09B (not a valid NDM EUC)

Strand 3: Data Issues

- There were a number of data issues with the 3rd Party provided data which have been identified during the analysis, these include:
 - Negative volumes
 - Volume spikes
 - Large numbers of consecutive missing volumes
 - Consumption grouped to a single day
 - Duplicates
 - Incorrect Market Sector Code on UK Link
 - Incorrect file format
- This year we saw a significant increase in the number of Day of the Week errors, further details will be included in the NDM Sample Update slides
- We now receive data from 27 Shippers, with each party's submission containing its own unique data issues to manage. It would be very helpful if future 3rd Party submissions could be checked before sending to Correla
- For more information on these checks, a presentation can be found on the Joint Office website [here](#)

Strand 3 – NDM Daily Demand Analysis

Gas Year 2020/21 Results

Strand 3: Observations / Assumptions

- Analysis includes (where numbers have allowed) a review of the newer EUCs introduced in Gas Year 2019/20 following the implementation of XRN4665
- These EUCs are reliant on the key data held in UK Link being correct, namely Market Sector Codes, Meter Type and Payment Method
- This Gas Year is the first one to be analysed where Gas Demand Profiles based on the new CWV formula/definitions and Seasonal Normal basis have been used in the NDM Supply Meter Point Demand Formula
- The analysis period is impacted by the COVID-19 pandemic and several key date ranges have been observed:
 - Second national lockdown - 05/11/20 to 02/12/2020 and Third national lockdown - 06/01/21 to 07/03/21
 - Freedom day on 19/07/21
- Additional period of interest include:
 - Strand 1 weather dates – Feb 2021 Storm Darcy, colder than normal April and May 2021
 - Strand 2 UIG shoulder period dates – October 2020 and May 2021
- Charts have been prepared to try and show demand trends in these date ranges

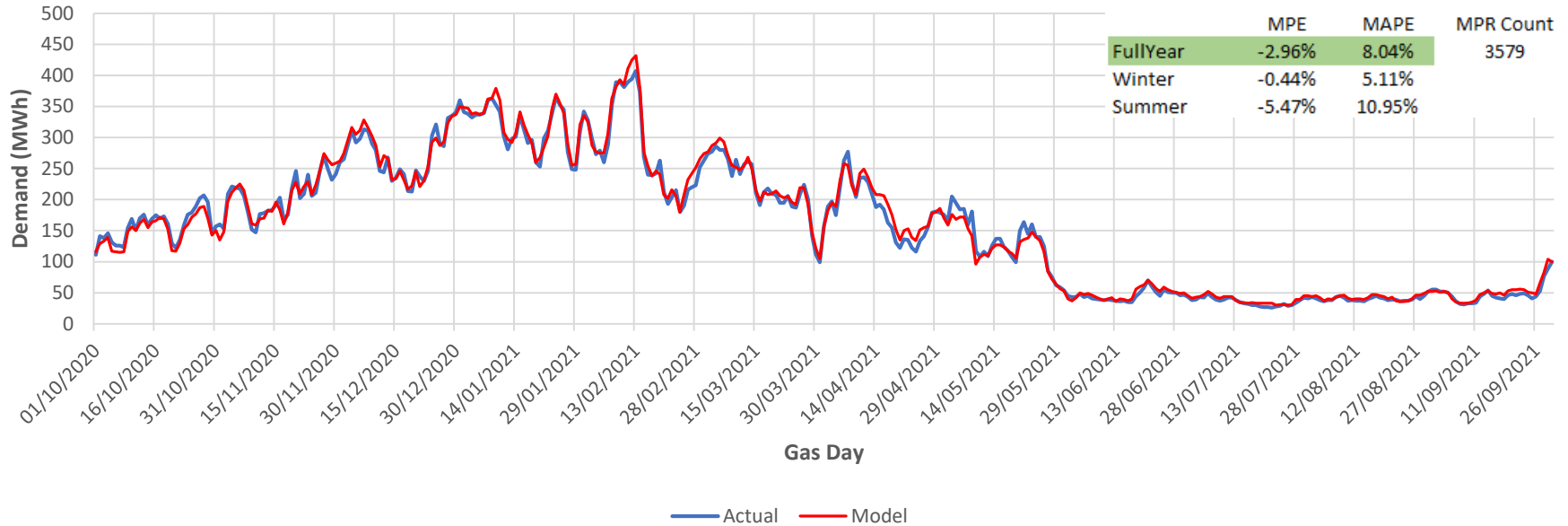
Strand 3 – NDM Daily Demand Analysis for Selected EUCs

01BND Results

Strand 3: MODEL – Band 01BND

MPE +ve = Under allocation
-ve = Over allocation

Daily Actual & Allocated Demands (Model) - Band 01BND (assessed against Domestic Sites)

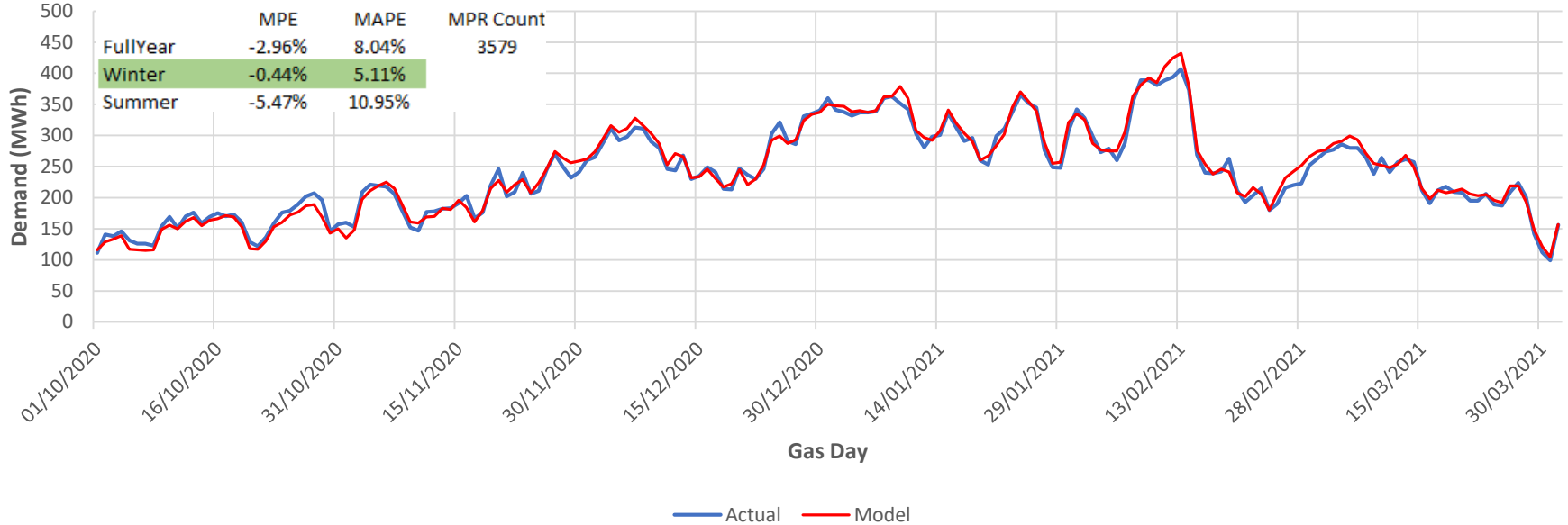


- Graph shows daily actual and allocated demand on Model basis for the full year
- The allocated demand follows the actual demand consistently throughout the Gas Year
- The following charts break the year into Winter and Summer where some of the less accurate allocation periods will be investigated further

Strand 3: MODEL – Band 01BND

MPE +ve = Under allocation
-ve = Over allocation

Daily Actual & Allocated Demands (Model) - Band 01BND (Winter - assessed against Domestic Sites)

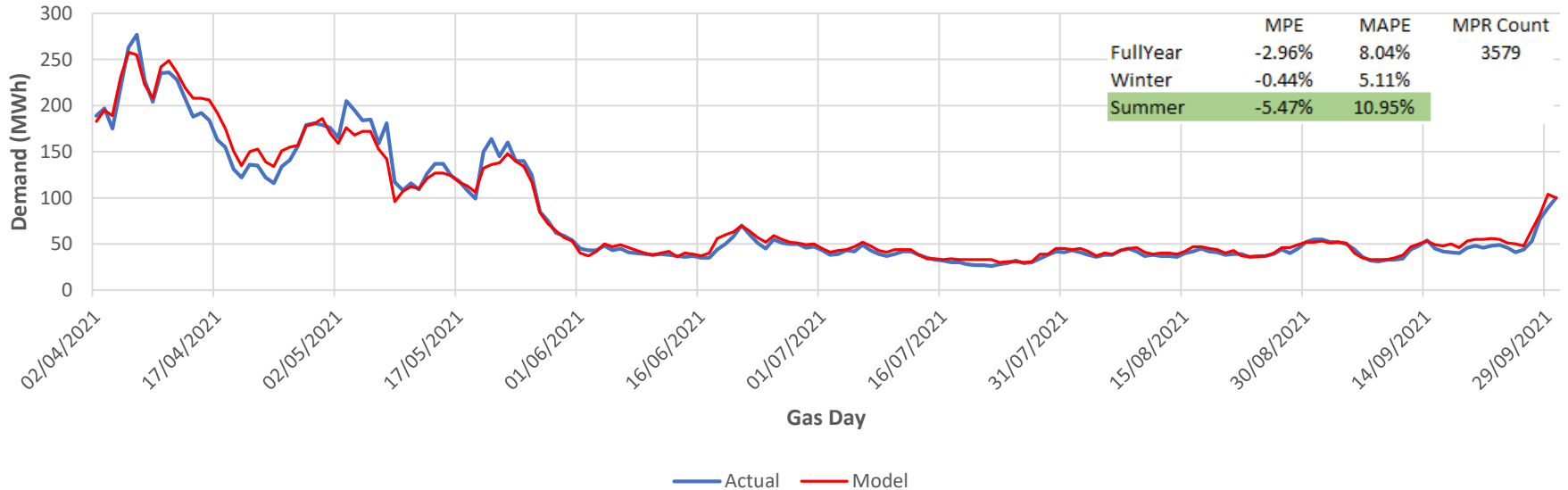


- Daily actual and allocated demand on Model basis for Winter
- Tracks closely to the actual demand with the tendency, if any, to over allocate with the more notable period in February 2021 which coincides with Storm Darcy as mentioned in Strand 1

Strand 3: MODEL – Band 01BND

MPE +ve = Under allocation
-ve = Over allocation

Daily Actual & Allocated Demands (Model) - Band 01BND (Summer - assessed against Domestic Sites)

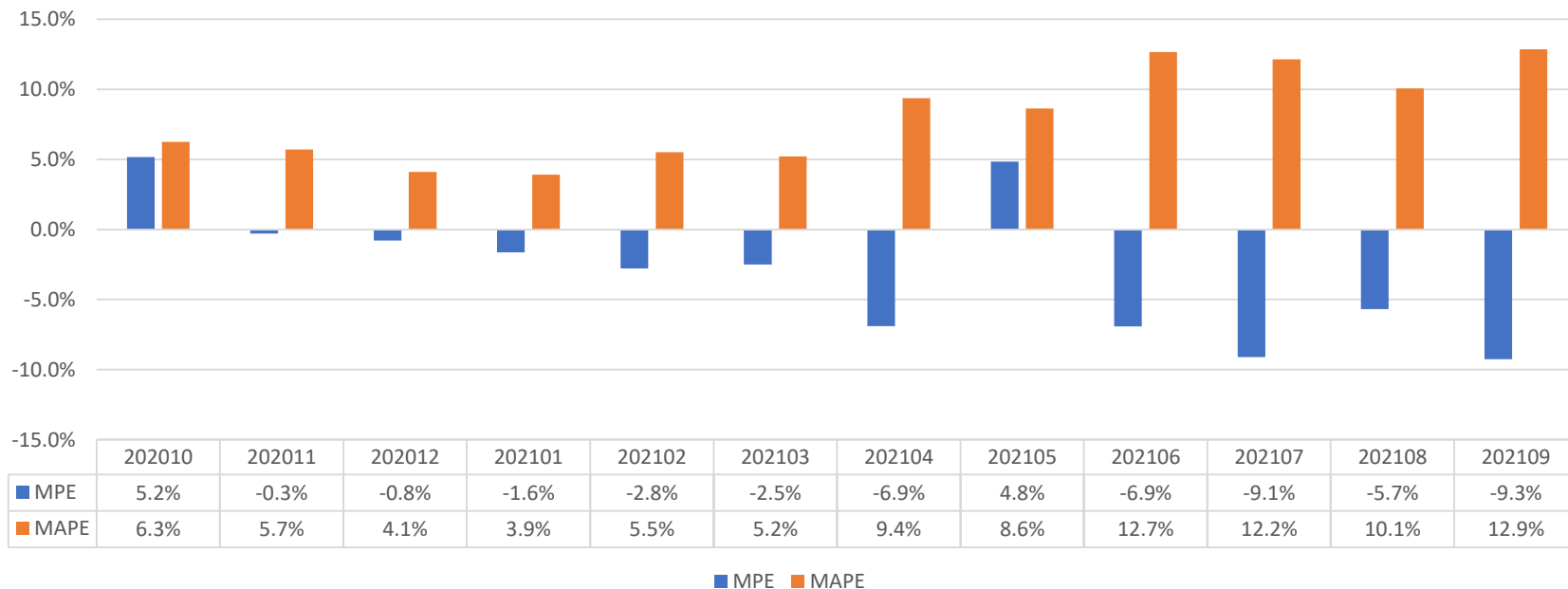


- Graph shows same assessment as previous graph but for Summer period. This is tracking very closely from June onwards
- Notable periods of over allocation occurred during 10th to 26th April 2021 and under allocation between 2nd and 9th May 2021
 - May was particularly cold and also may have been impacted by the May Holiday Codes
 - April was also colder than usual but no Holiday Code concerns

Strand 3: MODEL – Band 01BND

MPE +ve = Under allocation
-ve = Over allocation

01BND Monthly MPE VS MAPE

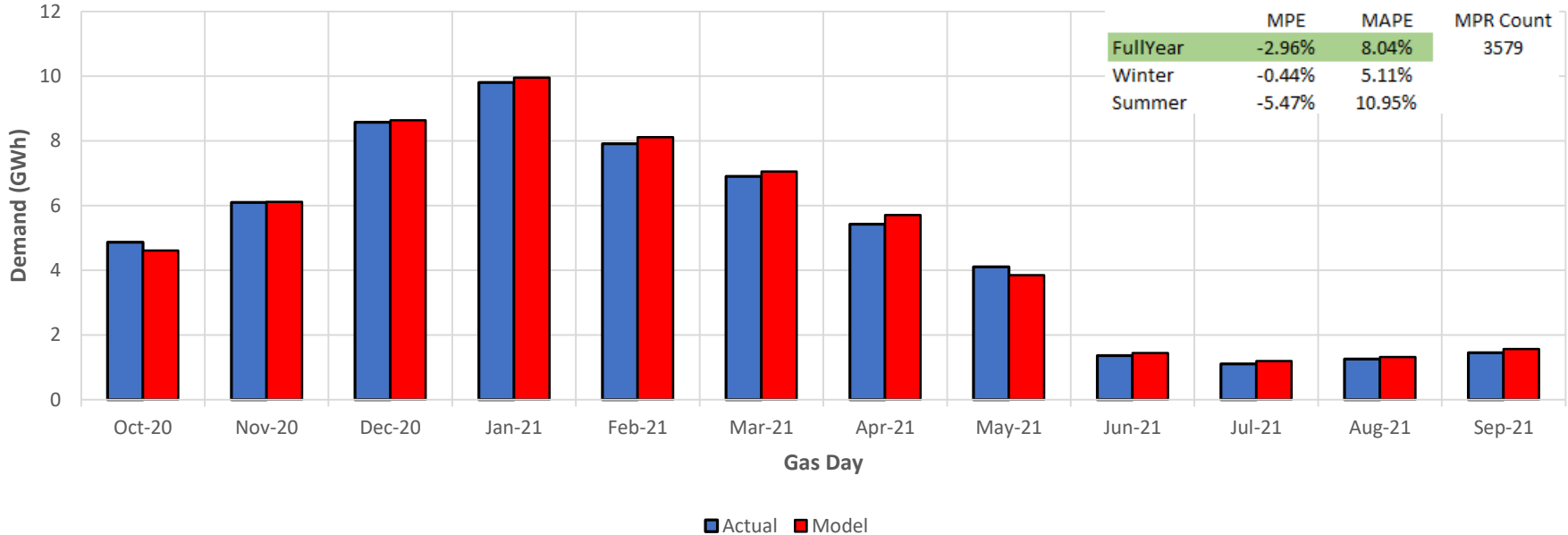


- This graph shows the calculated MEAN percentage error for 01BND by month
- The patterns in October and May are similar (i.e. under allocation). These 'shoulder months' are typically harder to model and so results can be less accurate. We know from Strand 1 analysis that October and May were much colder compared to Seasonal Normal. Early May also includes holiday reductions

Strand 3: MODEL – Band 01BND

Monthly Actual & Allocated Demands (Model) - Band 01BND (assessed against Domestic Sites)

MPE +ve = Under allocation
-ve = Over allocation



- Chart shows aggregated monthly actual and allocated demand for Band 01BND
- They are trending closely with an over allocation in Winter months except in October 2020
- For the Summer months an under allocation was present in May 2021 with the remaining months having marginal over allocation

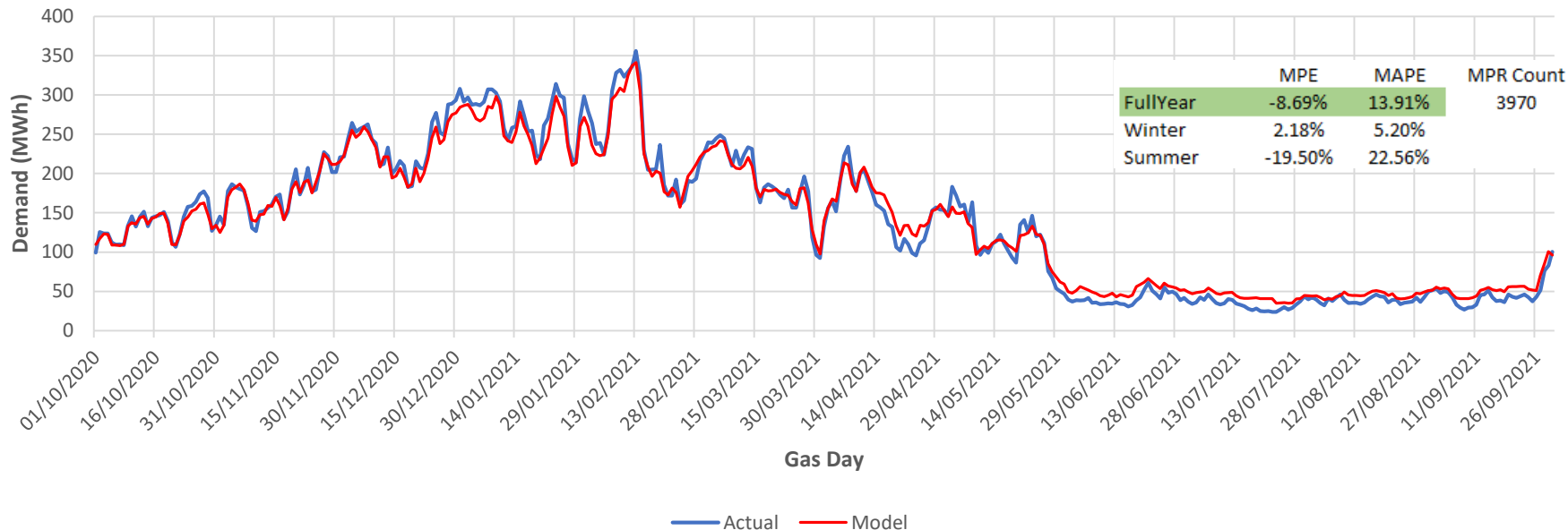
Strand 3 – NDM Daily Demand Analysis for Selected EUCs

01BPD Results

Strand 3: MODEL – Band 01BPD (Class 3 Data)

Daily Actual & Allocated Demands (Model) - Band 01BPD (assessed against Prepayment Sites)

MPE +ve = Under allocation
-ve = Over allocation

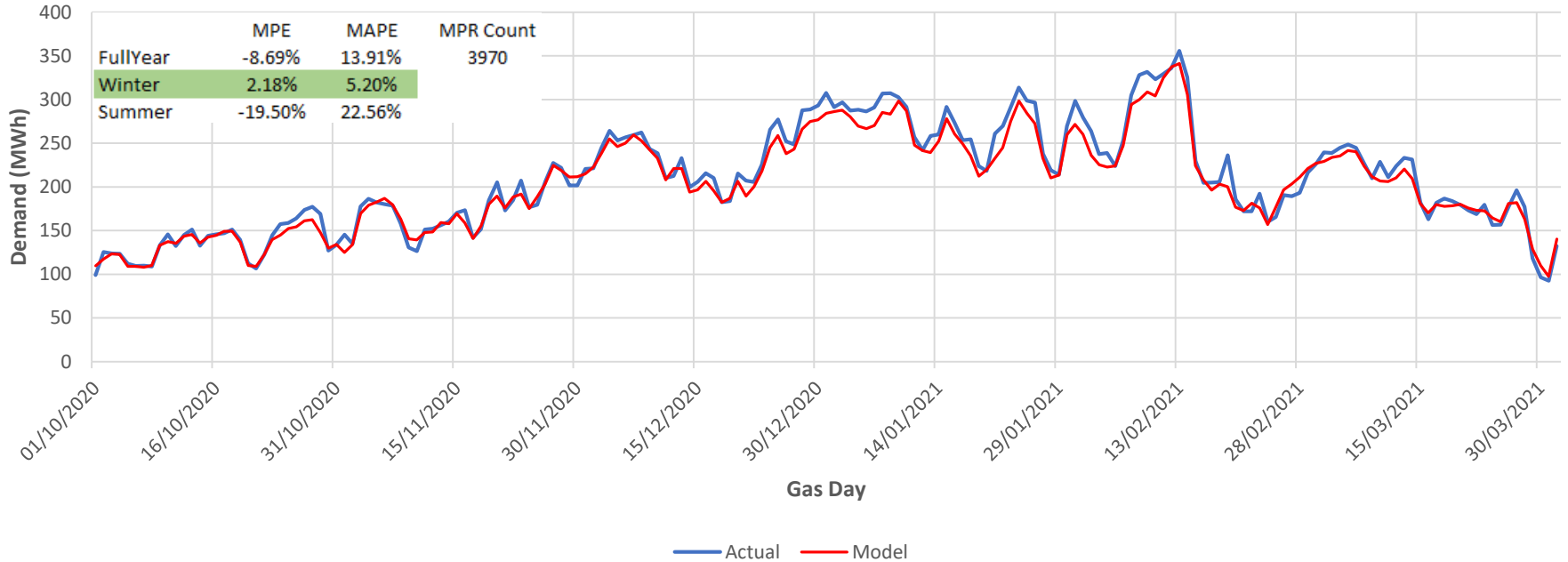


- Graph shows daily actual and allocated demand on Model basis for the full year, tracks closely throughout Winter but an overall over allocation in the Summer
- The 01BPD profile is derived on an underlying demand model that is based on very old sample data (2012/13), however it appears to provide a reasonable match to the actual demand, especially in Winter

Strand 3: MODEL – Band 01BPD (Class 3 Data)

Daily Actual & Allocated Demands (Model) - Band 01BPD (Winter - assessed against Prepayment Sites)

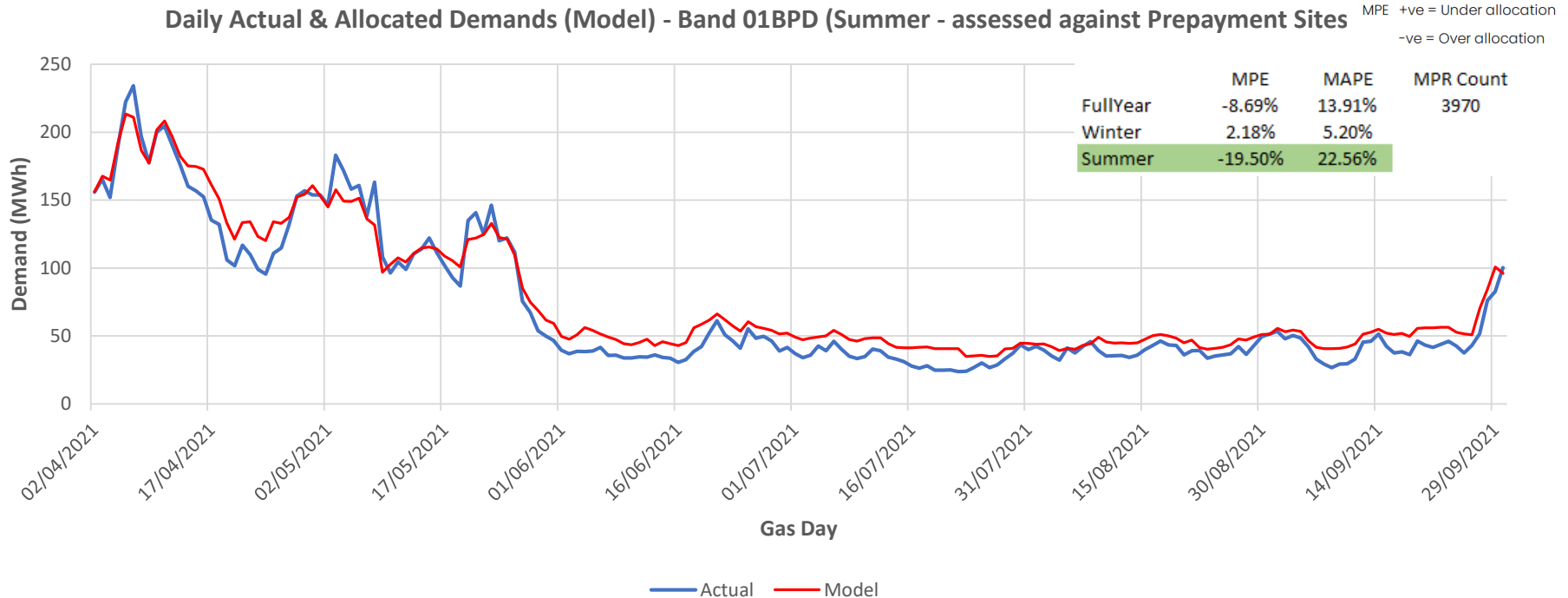
MPE +ve = Under allocation
-ve = Over allocation



- Graph shows daily actual and allocated demand on Model basis for the Winter period
- Tracks fairly closely with a tendency to under allocate

Strand 3: MODEL – Band 01BPD (Class 3 Data)

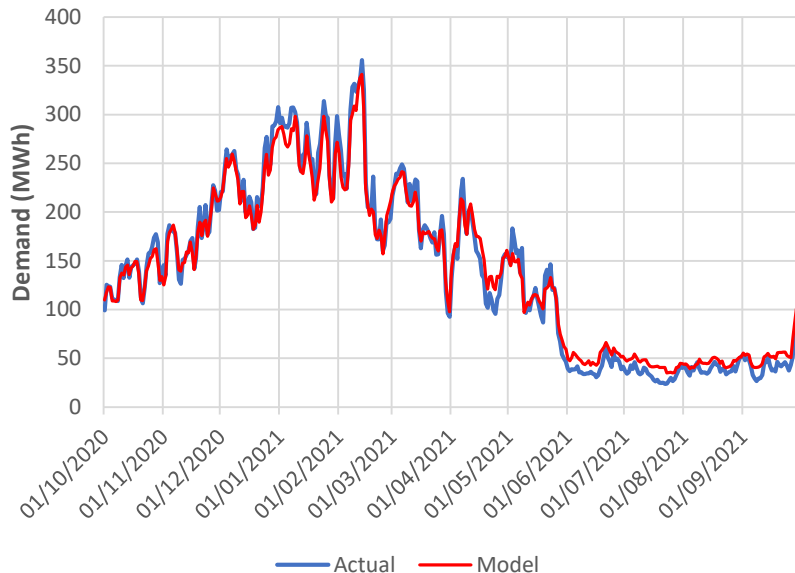
Daily Actual & Allocated Demands (Model) - Band 01BPD (Summer - assessed against Prepayment Sites)



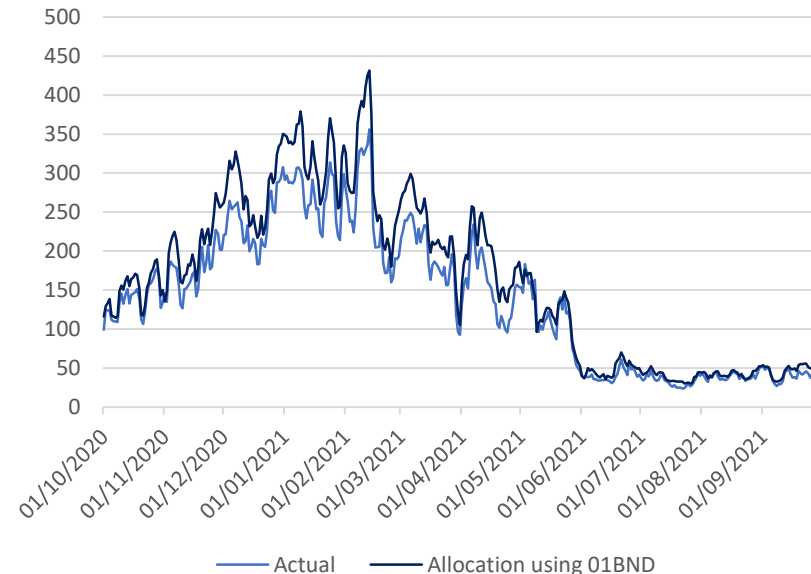
- Graph shows daily actual and allocated demand on Model basis for Summer
- Performance in Summer is considerably worse than Winter
- An updated demand model for 01BPD may help improve the performance of this EUC.

Strand 3: MODEL – Band 01BPD (Class 3 Data)

Daily Actual & Allocated Demands (Model) - Band 01BPD (assessed against Prepayment Sites)



Daily Actual & Allocated Demands (Model) - Band 01BND (assessed against Prepayment Sites)

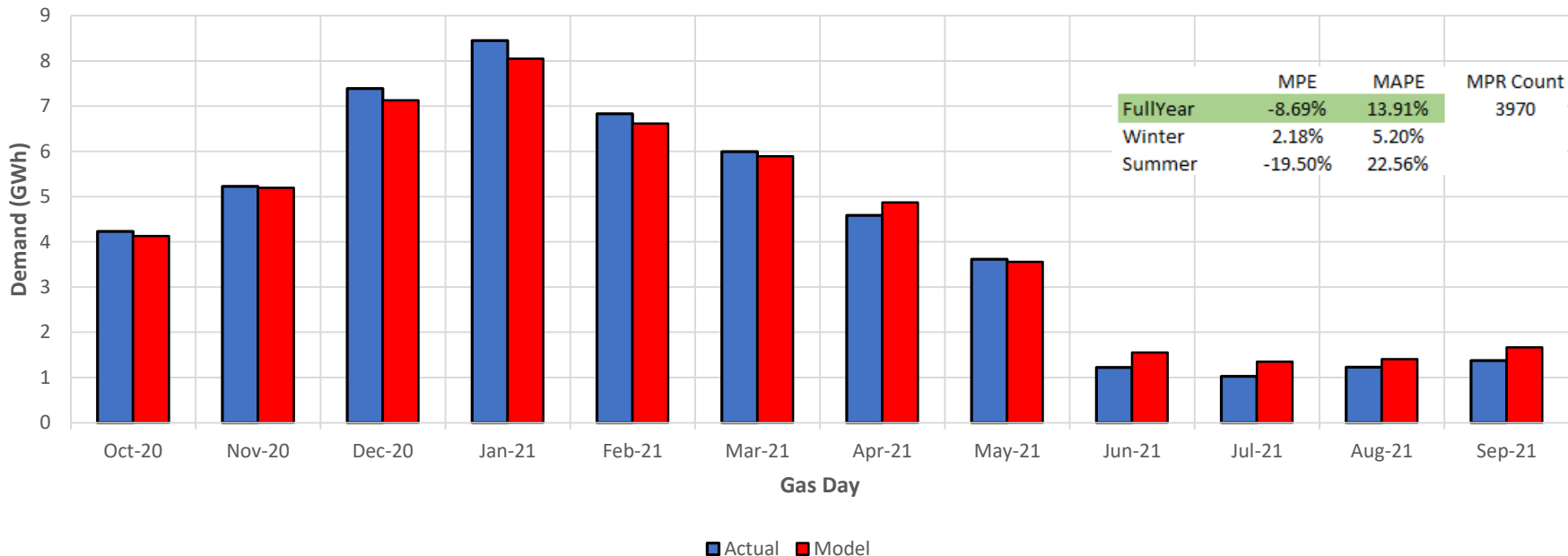


- This chart shows a comparison of the 01BPD sites against the 01BND profile
- The data clearly shows that the 01BPD profile is still a much better fit for the Pre-Payment sites in the Winter, however, tends to match 01BND profile closely in the Summer
- There are circa 2m supply points benefitting from this new EUC where the Winter allocation, at least, is more accurate than the 01BND profile (these sites would have once used- prior to Gas Year 2019/20)

Strand 3: MODEL – Band 01BPD (Class 3 Data)

Monthly Actual & Allocated Demands (Model) - Band 01BPD (assessed against Domestic Sites)

MPE +ve = Under allocation
-ve = Over allocation



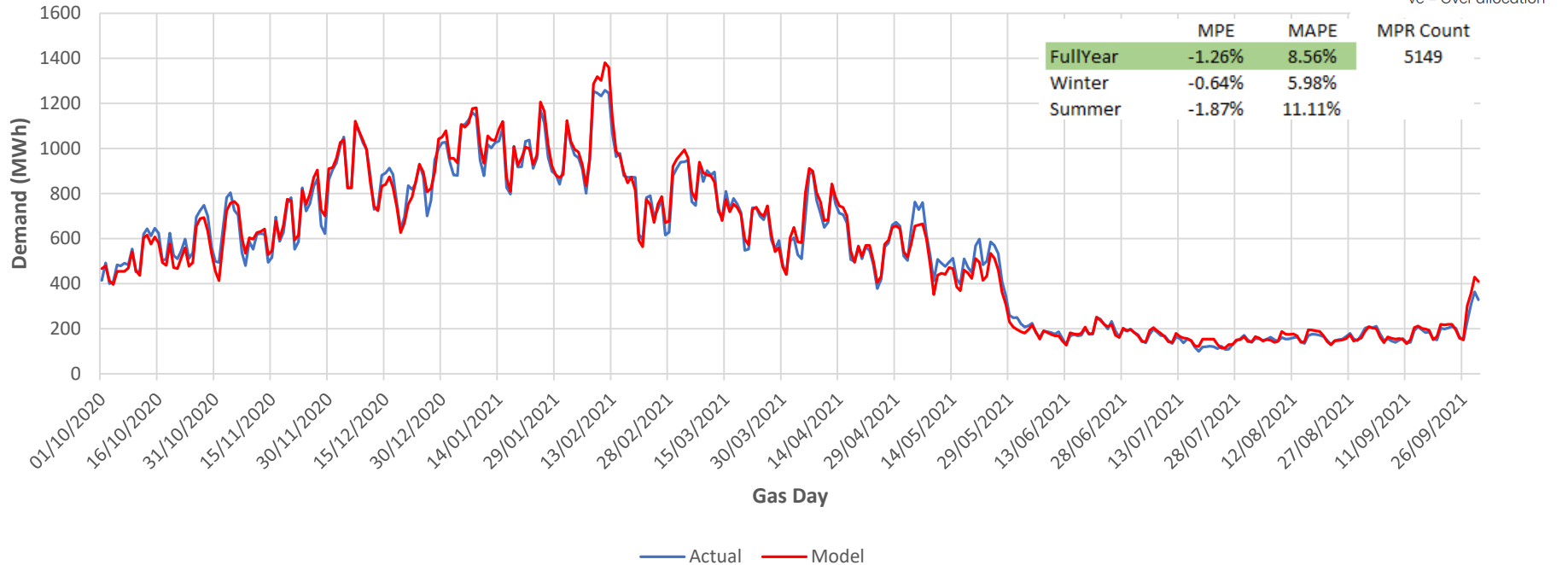
- Chart shows aggregated monthly actual and allocated demand for Band 01BPD
- They are trending closely with an over allocation in the Summer months except in May 2021
- An under allocation was present in all of Winter

Strand 3 – NDM Daily Demand Analysis for Selected EUCs

01BNI Results

Strand 3: MODEL – Band 01BNI

Daily Actual & Allocated Demands (Model) - Band 01BNI (assessed against I&C Sites)

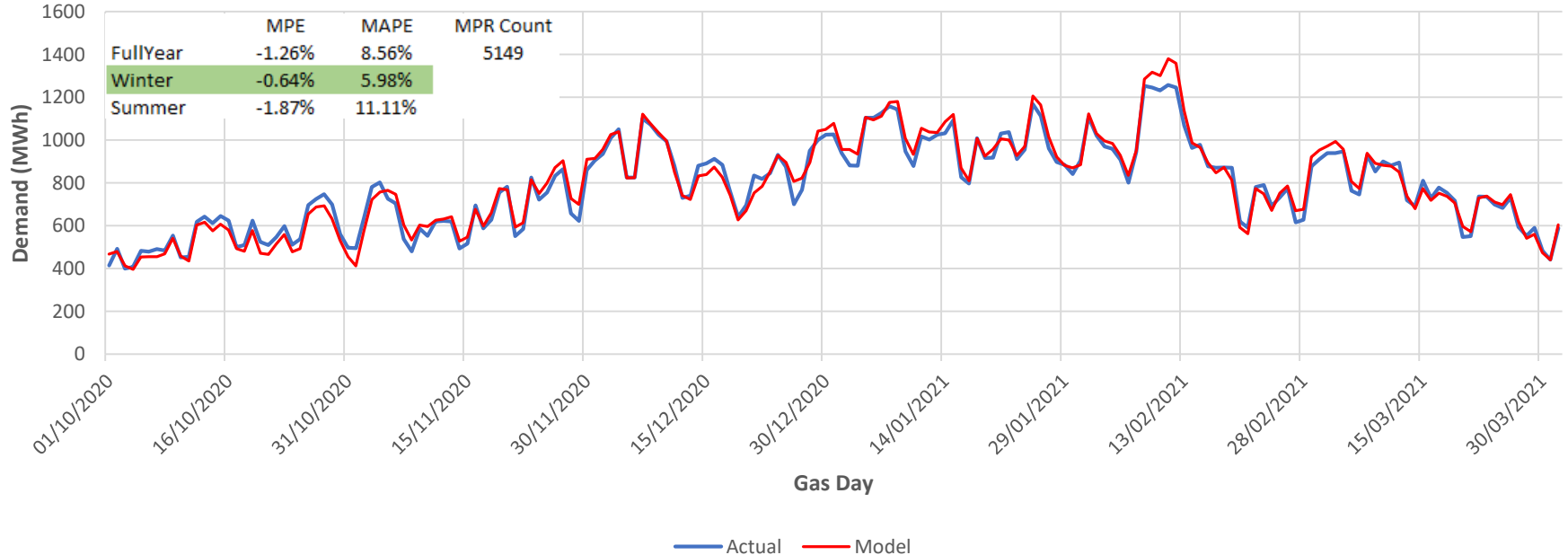


- Graph shows daily actual and allocated demand on Model basis for the full year
- Generally, the model follows the actual demand well
- The following charts break the year into Winter and Summer

Strand 3: MODEL – Band 01BNI

Daily Actual & Allocated Demands (Model) - Band 01BNI (Winter - assessed against I&C Sites)

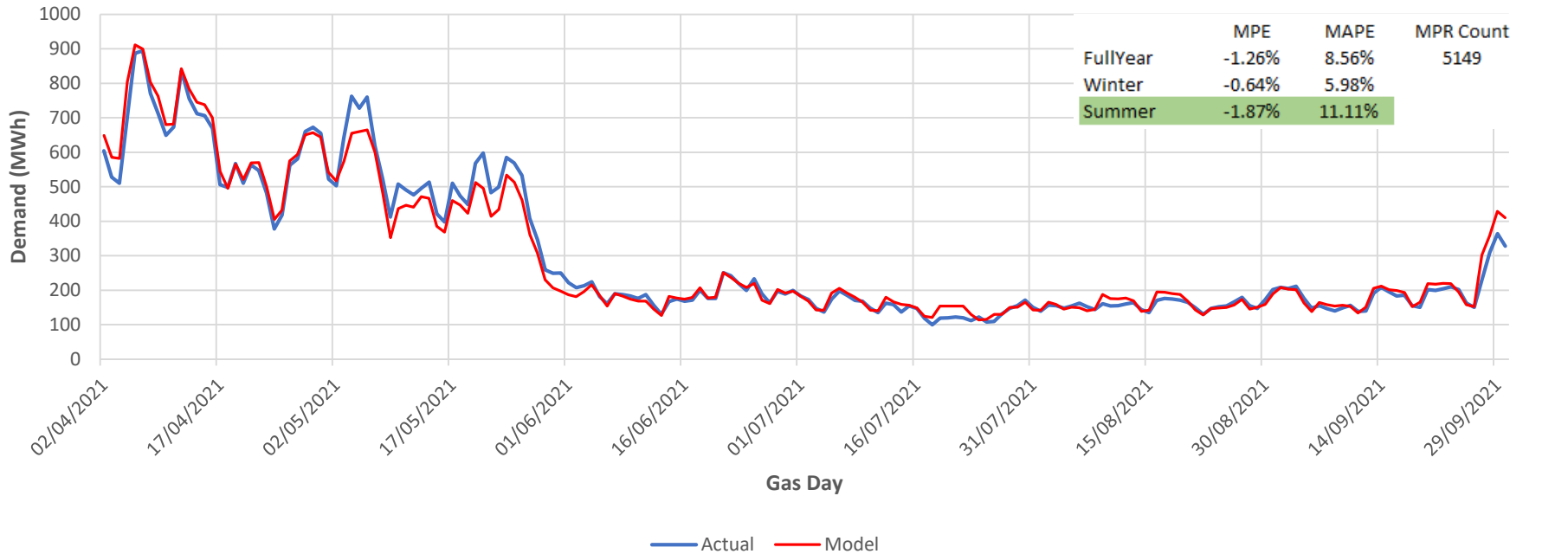
MPE +ve = Under allocation
-ve = Over allocation



- Graph shows daily actual and allocated demand on Model basis for Winter
- Tracks well for most of the period but with a notable over allocation from 8th to the 12th February 2021 which coincides with Storm Darcy

Strand 3: MODEL – Band 01BNI

Daily Actual & Allocated Demands (Model) - Band 01BNI (Summer - assessed against I&C Sites)

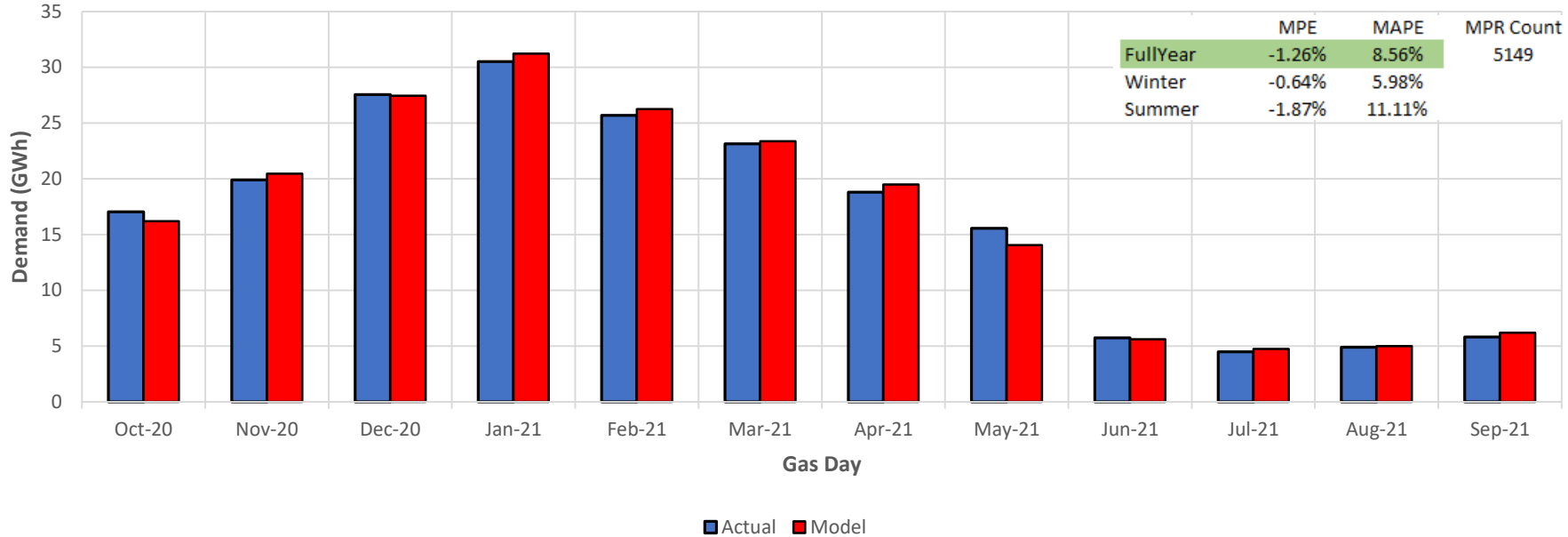


- This graph for the Summer period mainly continues to track well
- There were two noticeable periods of under allocation between 2nd May 2021 to 2nd June 2021

Strand 3: MODEL – Band 01BNI

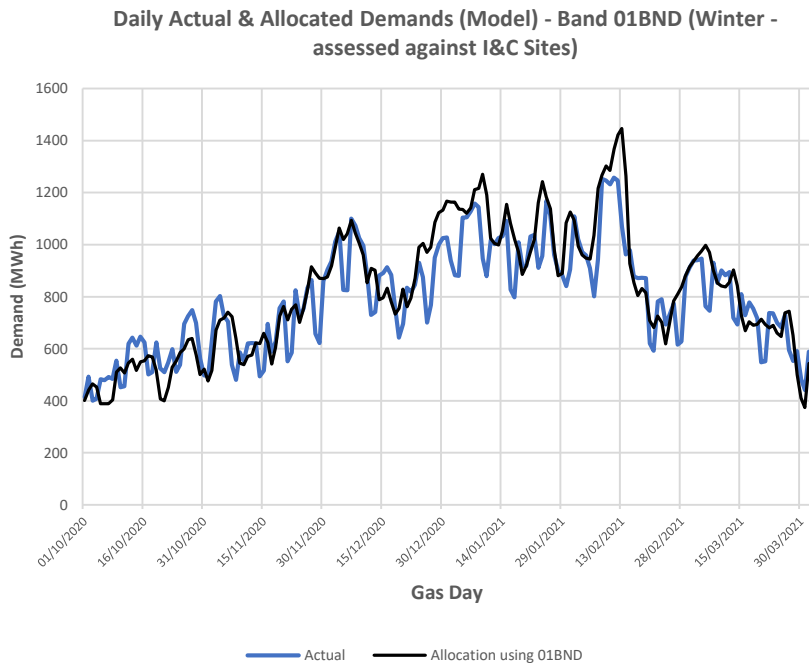
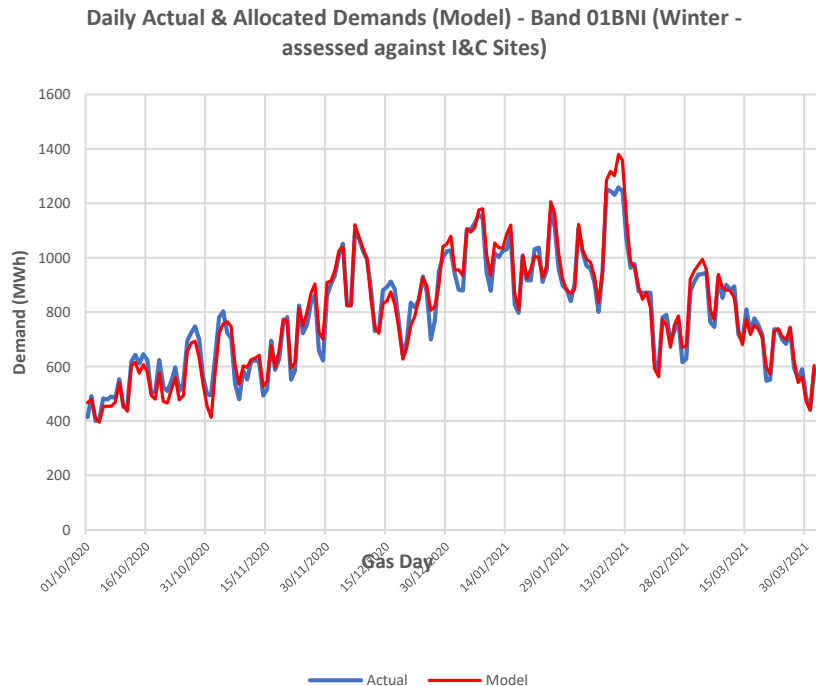
Monthly Actual & Allocated Demands (Model) - Band 01BNI (assessed against I&C Sites) MPE +ve = Under allocation

-ve = Over allocation



- Chart shows aggregated monthly actual and allocated demand for Band 01BNI
- There is a clear over allocation in Winter months except for October 2020
- For the Summer months an under allocation was present for May and June 2021 with the remaining months having marginal over allocation

Strand 3: MODEL – Band 01BNI Tested against 01BND



- These charts show a comparison of the 01BNI sites against its assigned EUC (left) and the 'traditional' 01BND profile (right).
- The results continue to confirm that the decision to introduce more refined EUCs into Bands 1 and 2 was necessary
- There are circa 503,000 meter points now benefiting from a more appropriate I&C profile (as at 1st October 2021).

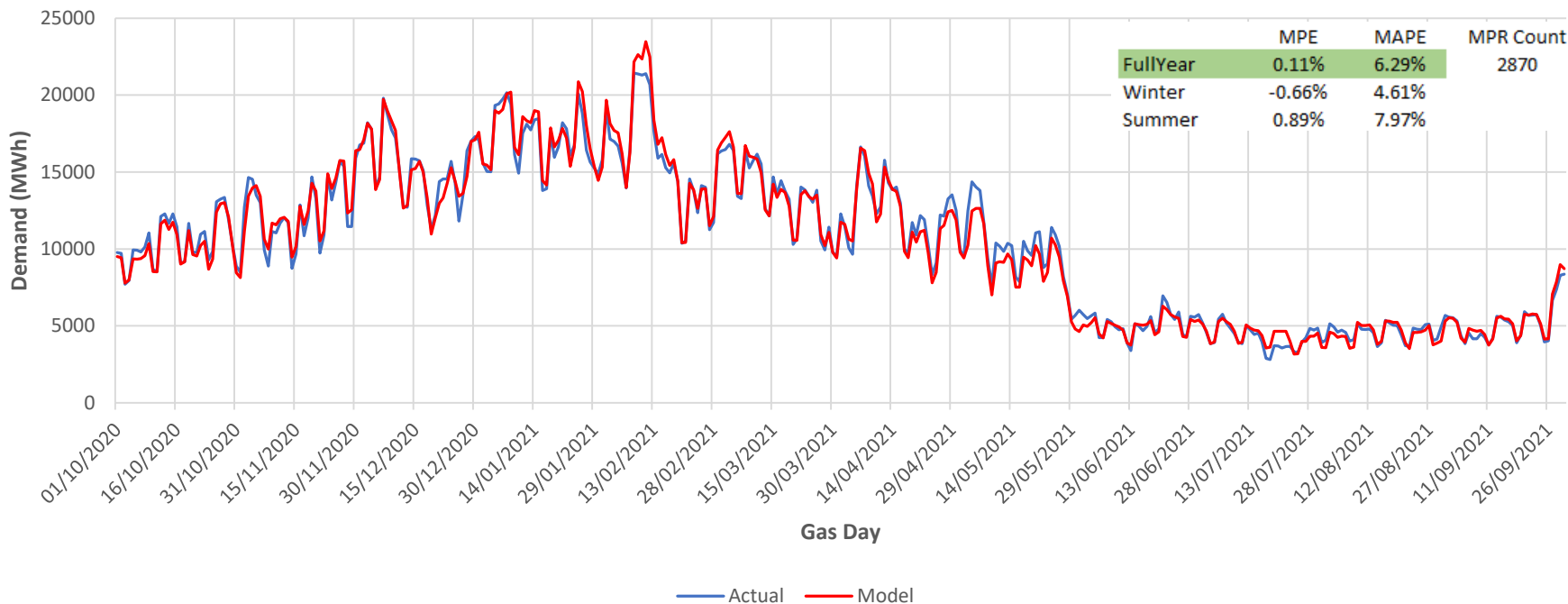
Strand 3 – NDM Daily Demand Analysis for Selected EUCs

04B and 06B Results

Strand 3: MODEL – Band 04B

Daily Actual & Allocated Demands (Model) - Band 04B (assessed against I&C Sites)

MPE +ve = Under allocation
-ve = Over allocation

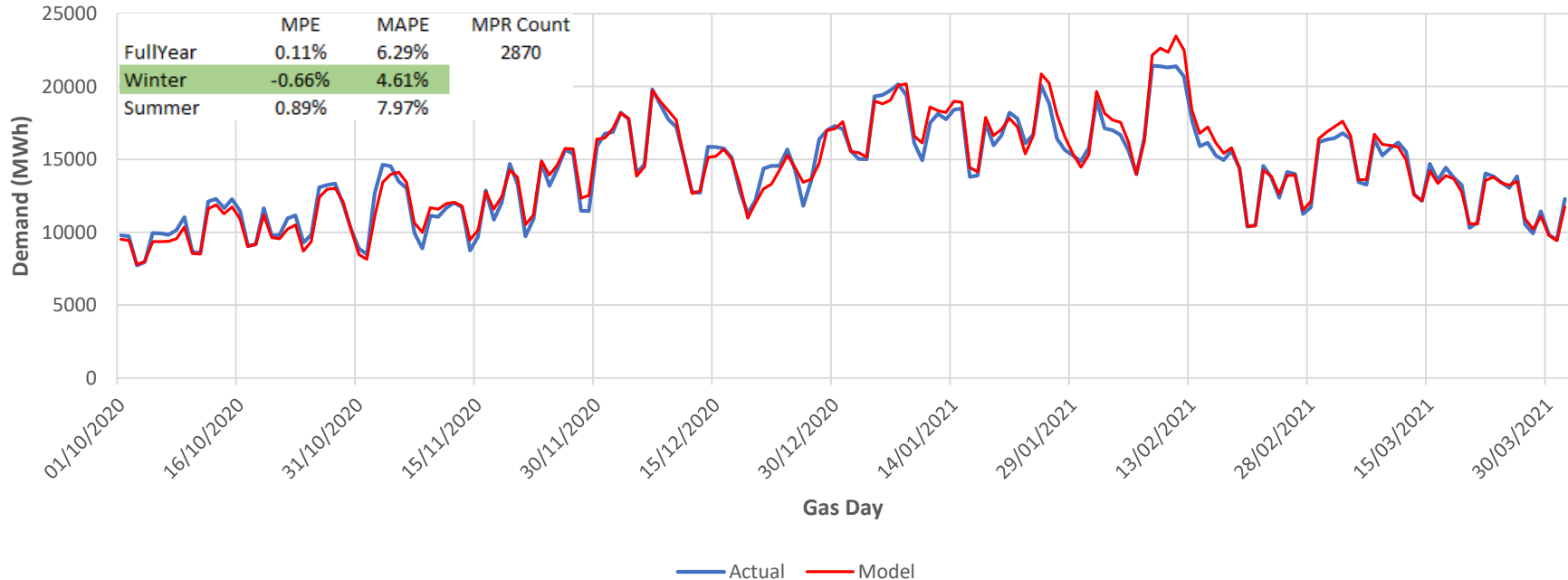


- Graph shows daily actual and allocated demand on Model basis for the full year
- Generally, the model follows the actual demand well
- The following charts break the year into Winter and Summer

Strand 3: MODEL – Band 04B

MPE +ve = Under allocation
-ve = Over allocation

Daily Actual & Allocated Demands (Model) - Band 04B (Winter - assessed against I&C Sites)

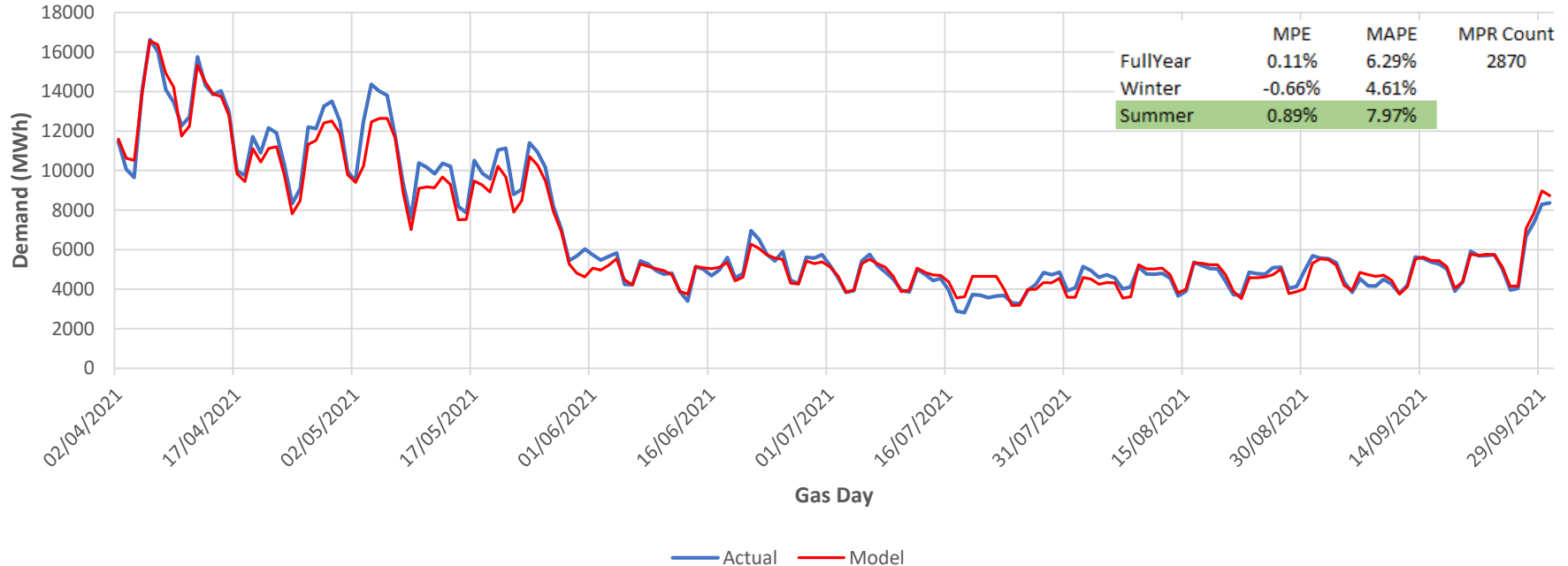


- Graph shows daily actual and allocated demand on Model basis for Winter
- Tracks well throughout most of Winter with a notable period of over allocation from the 8th to the 12th of February 2021 (Storm Darcy)

Strand 3: MODEL – Band 04B

MPE +ve = Under allocation
-ve = Over allocation

Daily Actual & Allocated Demands (Model) - Band 04B (Summer - assessed against I&C Sites)

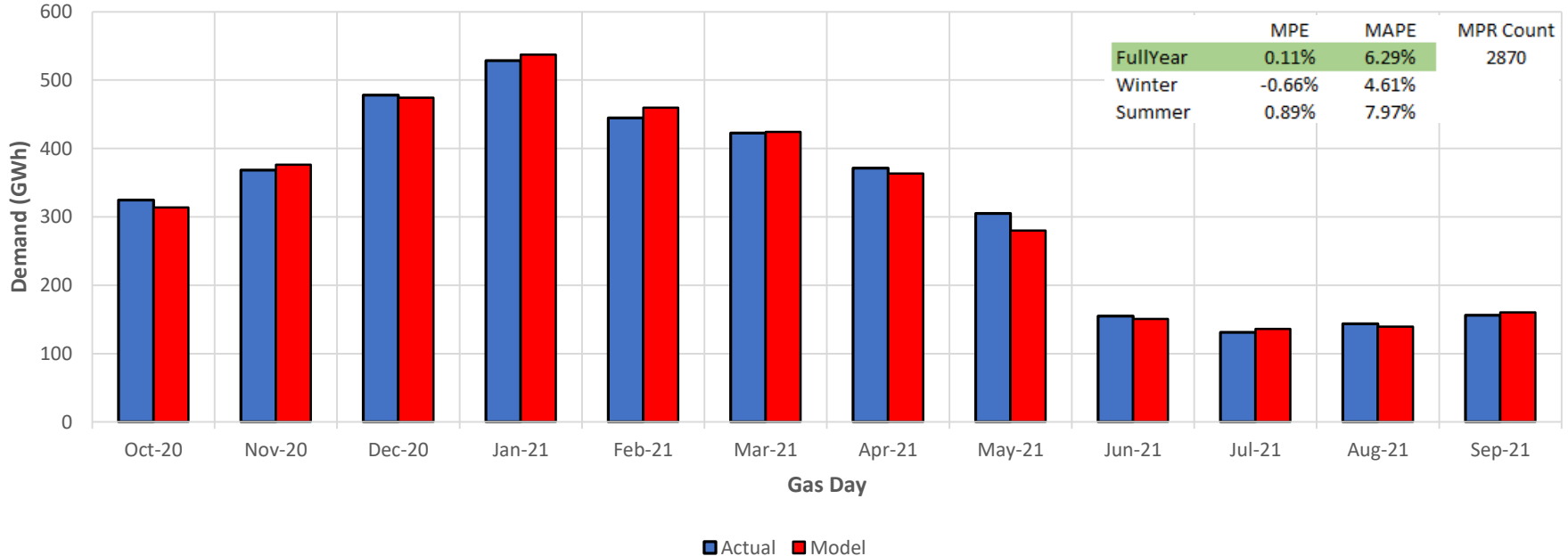


- The model for the Summer period tracks actual reasonably well
- There was a notable period of under allocation between 26th April 2021 to 2nd June 2021

Strand 3: MODEL – Band 04B

Monthly Actual & Allocated Demands (Model) - Band 04B (assessed against I&C Sites)

MPE +ve = Under allocation
-ve = Over allocation

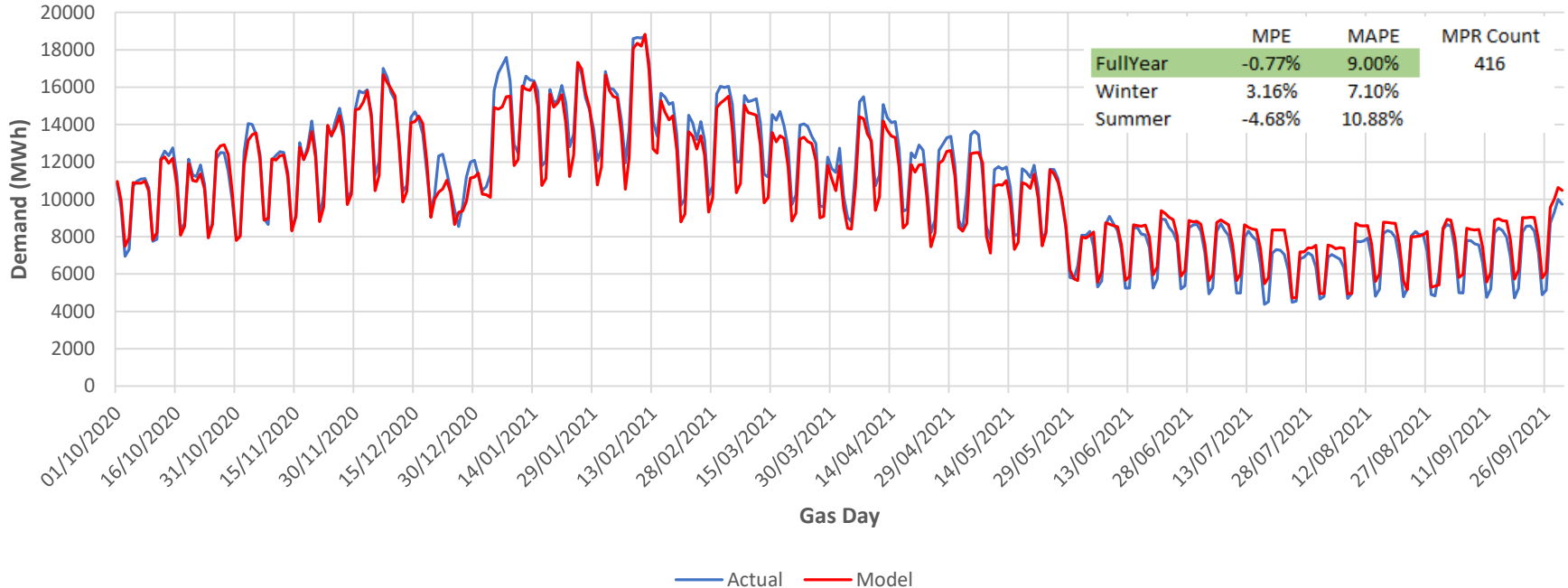


- Chart shows aggregated monthly actual and allocated demand for Band 03B
- There is a clear over allocation in most Winter months except for October 2020 and December 2020
- For the Summer months a slight over allocation was present for July 2021 and September 2021 but overall a marginal under allocation

Strand 3: MODEL – Band 06B

Daily Actual & Allocated Demands (Model) - Band 06B (assessed against I&C Sites)

MPE +ve = Under allocation
-ve = Over allocation

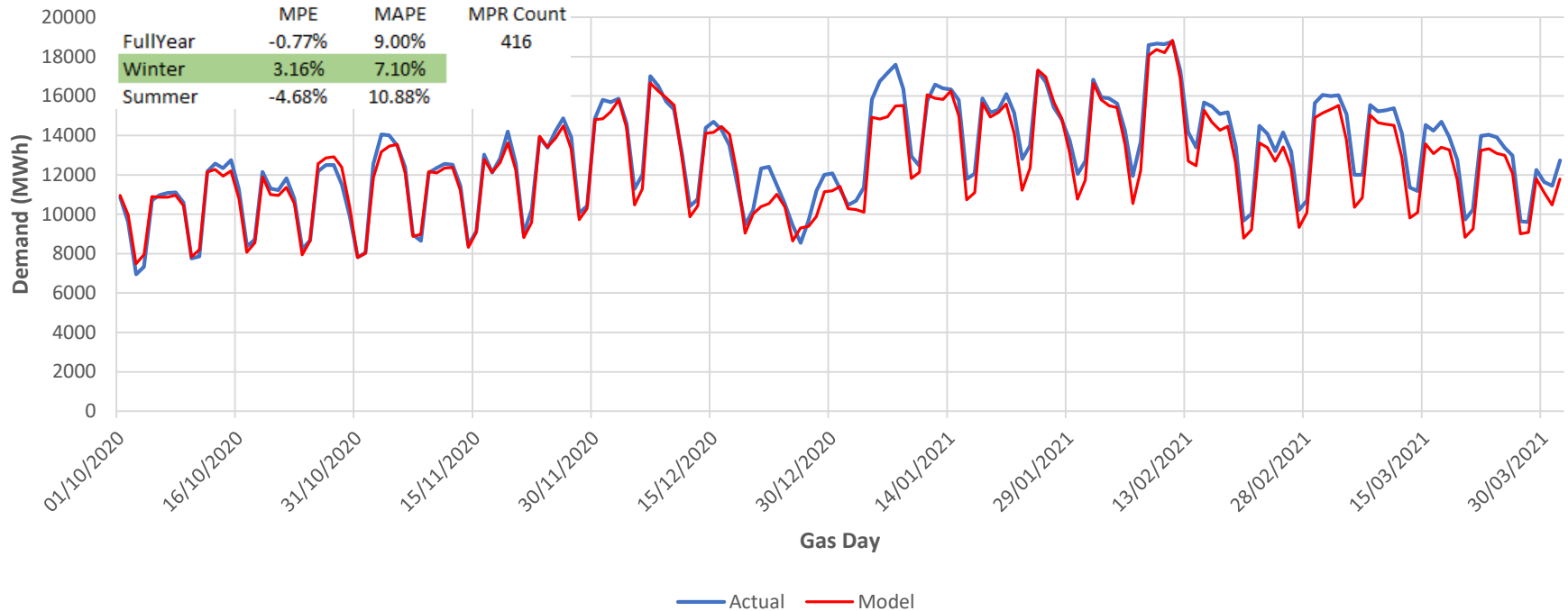


- Graph shows daily actual and allocated demand on Model basis for the full year
- Generally the model follows the actual demand well, although notable under allocation in Spring and over allocation in Winter. The following charts break the year into Winter and Summer

Strand 3: MODEL – Band 06B

MPE +ve = Under allocation
-ve = Over allocation

Daily Actual & Allocated Demands (Model) - Band 06B (Winter - assessed against I&C Sites)

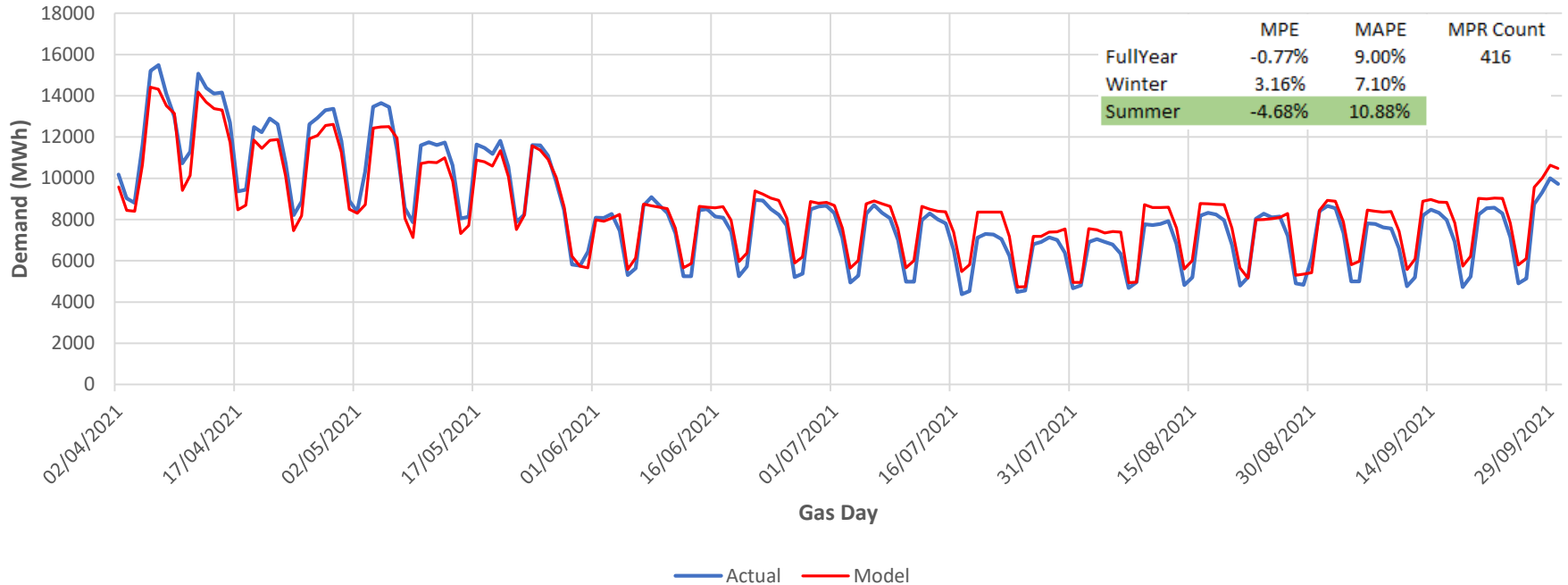


- Graph shows daily actual and allocated demand on Model basis for Winter
- Generally, tracks well, but with notable periods of consistent under allocation
- The 21st December 2020 to 8th January 2021 signalled a period of under allocation (mainly holiday period)

Strand 3: MODEL – Band 06B

MPE +ve = Under allocation
-ve = Over allocation

Daily Actual & Allocated Demands (Model) - Band 06B (Summer - assessed against I&C Sites)

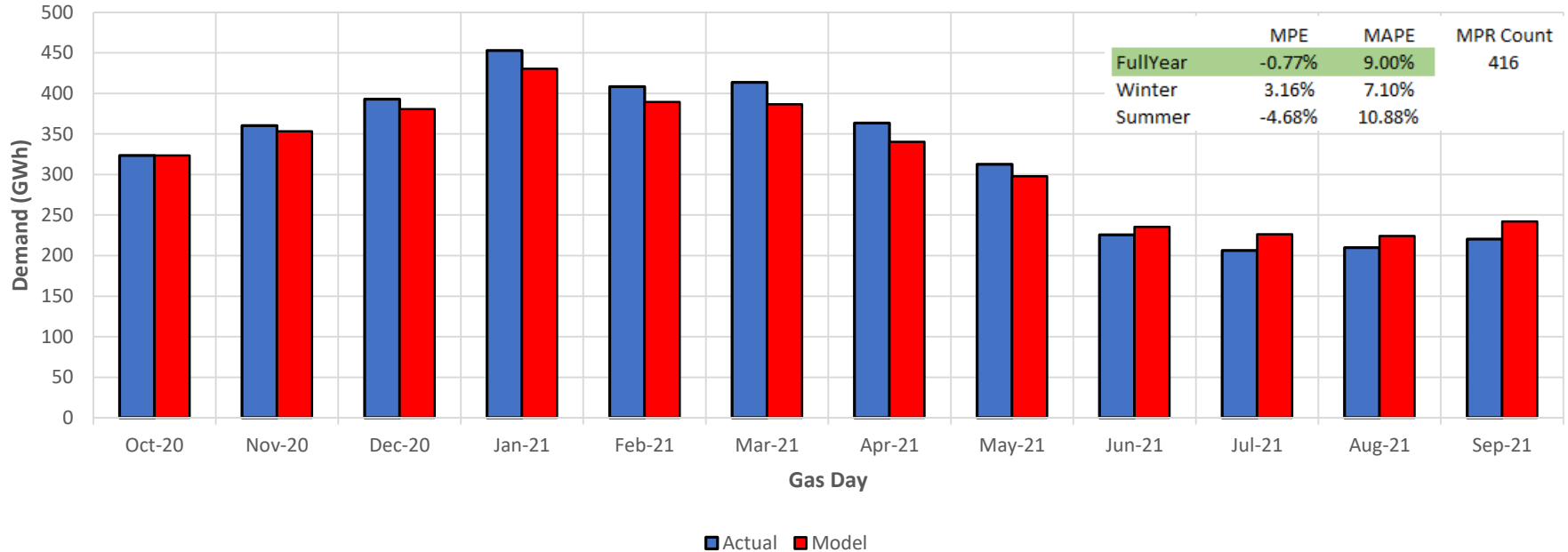


- Summer period continues the trend of under allocation until June 2021 when there is a consistent level of over allocation for the remainder of the period

Strand 3: MODEL – Band 06B

MPE +ve = Under allocation
-ve = Over allocation

Monthly Actual & Allocated Demands (Model) - Band 06B (assessed against I&C Sites)



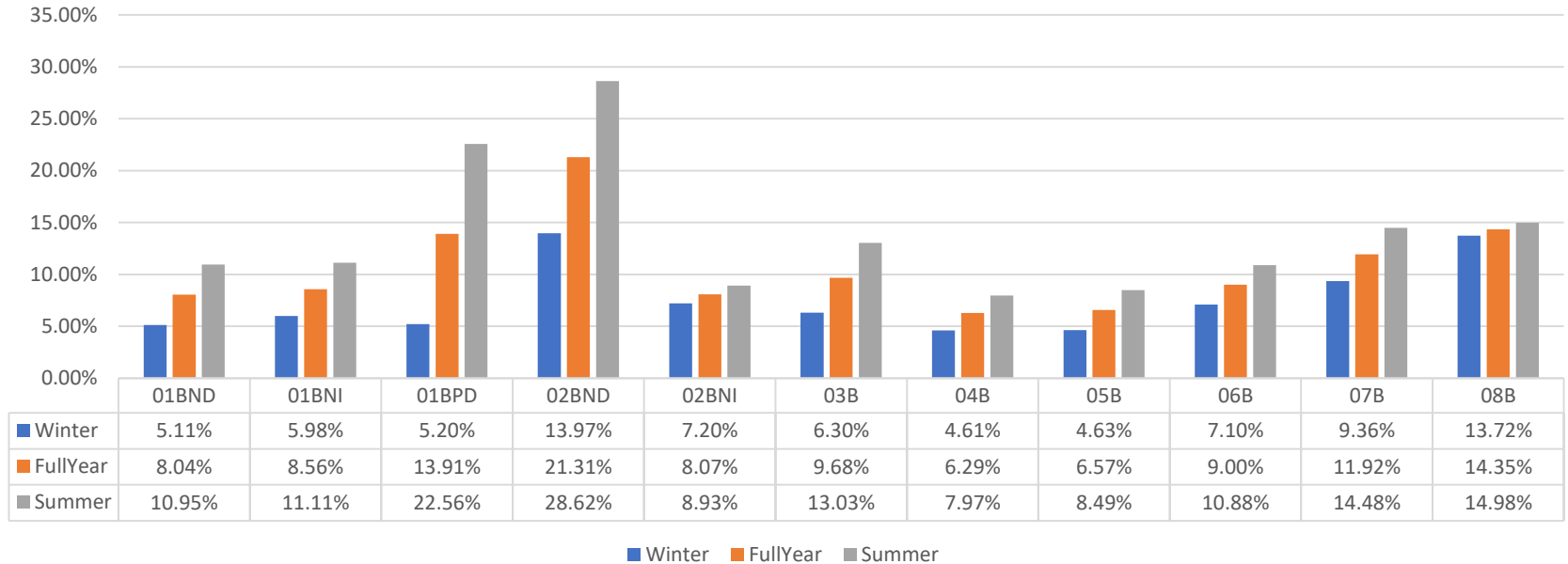
- Chart shows aggregated monthly actual and allocated demand for Band 06B
- There is a clear under allocation in all Winter months.
- In most of the Summer months there has been an over allocation except for April to May 2021.

Strand 3 – NDM Daily Demand Analysis for all EUCs

All EUC Summary Results

Strand 3: MODEL – EUC Band Summary

Mean Absolute Percentage Error (MAPE) by Season - MODEL Basis



- Chart shows simple summary of the overall error on the 'MODEL' basis
- Full Year MAPE values range from 6.29% (7.6% - 2020) to 21.31% (22.8% - 2020)
- Band 2 Domestic (02BND) worst performing model – possibly linked to incorrect Market Sector Codes ?
- Summer demands are lower than Winter demands, therefore percentage errors often greater in the Summer.

Strand 3: MODEL

Current vs Previous Year

- Table shows comparison of Full Year MAPE by EUC against the equivalent analysis from the previous year, where available, on the 'MODEL' basis
- Green denotes an improvement; Red denotes a worsening
- The majority of I&C EUCs show an improvement in allocation over the full year – less COVID impacts
- 01BPD is N/A this year as there was no previous model to compare to
- Both domestic profiles show an increase in MAPE

Profiles	2019/20 Profiles		2020/21 Profiles		
Analysis	MODEL using 2019/20 Data		MODEL using 2020/21 Data		
EUC	Sample Count	MAPE (Full Year)	Sample Count	MAPE (Full Year)	vs Previous Year
01BND	4,762	7.61%	3,579	8.04%	0.43%
01BNI	3,215	12.81%	5,149	8.56%	-4.25%
01BPD	0		3,970	13.91%	N/A
01BPI	0		0		
02BND	121	19.81%	113	21.31%	1.50%
02BNI	5,592	19.17%	6,940	8.07%	-11.10%
02BPD	0		0		
02BPI	0		0		
03B	3,073	13.89%	2,869	9.68%	-4.21%
04B	3,225	11.17%	2,870	6.29%	-4.88%
05B	1,338	14.67%	1,111	6.57%	-8.10%
06B	462	15.75%	416	9.00%	-6.75%
07B	147	16.72%	159	11.92%	-4.80%
08B	64	22.83%	70	14.35%	-8.48%

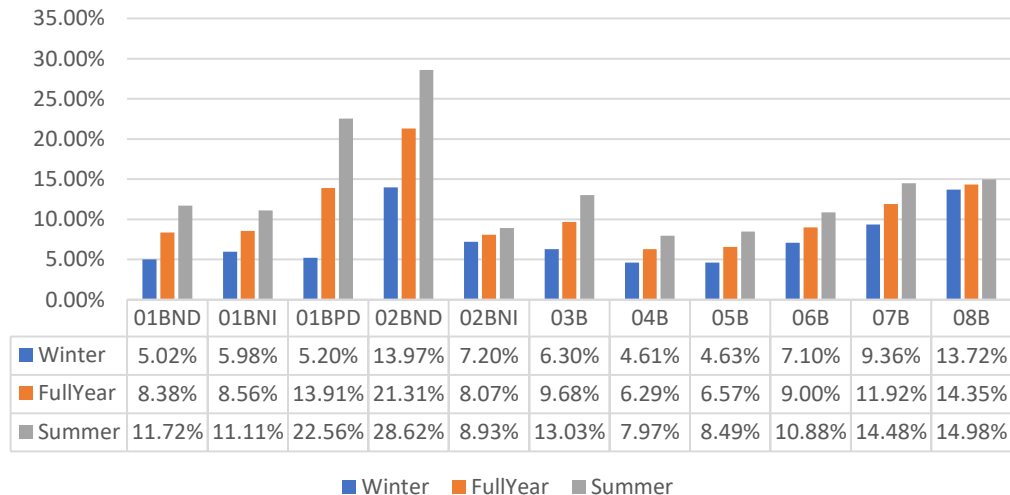
Strand 3: Retro Basis Analysis

- The 'RETRO' analysis is based on the algorithms derived for the current Gas Year (i.e. 2021/22) but retro fitted with appropriate adjustment for the pattern of days of the week and holidays for Gas Year 2020/21
- This analysis is helpful in assessing the performance of the most current algorithms had they applied to the gas year being analysed
- **RETRO: Allocated using:**
 - NDM sample derived AQs
 - 2021/22 ALPs and DAFs (adjusted to day/holiday pattern in 2020/21) and
 - 2020/21 Weather Correction Factors (WCF)

Strand 3: Retro – EUC Band Summary

- Chart shows simple summary of the overall error on the ‘Retro’ basis
- Table shows MAPE difference compared to equivalent ‘Model’ assessment
- All I&C EUCs for 2021 reused the previous years Model as per DESC’s request to manage concerns of the COVID impacted sample data – hence all the differences are 0

Mean Absolute Percentage Error (MAPE) by Season - RETRO Basis



EUC	MAPE Diff (Retro minus Model)		
	Winter	FullYear	Summer
01BND	-0.1%	0.3%	0.8%
01BNI	0.0%	0.0%	0.0%
01BPD	0.0%	0.0%	0.0%
02BND	0.0%	0.0%	0.0%
02BNI	0.0%	0.0%	0.0%
03B	0.0%	0.0%	0.0%
04B	0.0%	0.0%	0.0%
05B	0.0%	0.0%	0.0%
06B	0.0%	0.0%	0.0%
07B	0.0%	0.0%	0.0%
08B	0.0%	0.0%	0.0%

Strand 3 – NDM Daily Demand Analysis for all EUCs

Conclusions

Strand 3: Conclusions – Algorithm Accuracy

NDM Daily Demand Analysis headlines:

- The overall results are reassuring as most models have performed well. Summer has larger modelling error due to reduced overall demands
- Less evidence in this years results of COVID pandemic impacts, although sites impacted may have been removed during validation or already closed down. Alternatively AQs may now be more representative. In higher EUC bands, loads may be more process and less about space heating
- The overall shape of most models are sound but there are areas for improvement, such as shoulder periods and unusual weather events (e.g. large deviation from seasonal normal)

Analysis of the EUC Profiles:

- The 01BNI EUC has continued to show it fits the demand pattern better than the traditional 01BND profile
- 02BND with its 21.31% Full Year MAPE is potentially showing signs of incorrect Market Sector Codes, although the analysis is limited by the small number of sites in the sample (113) for this EUC
- 01BPD profiles (Mod 451) seems to work well over the Winter period, however it is not so accurate over the Summer period. Would benefit from using Class 3 data to derive next years model ?
- To fully utilise these new profiles, Shippers must ensure the Market Sector Code flag and Payment Method held on UK Link is correct and upto date for their portfolios

Strand 3: Conclusions – Modelling Approach

- **Modelling Approach for Gas Year 2022/23 (in Spring 2022):**
 - Strand 3 analysis confirms that new EUC definitions in bands 01B and 02B (including PPM) should continue
 - Holiday Code Rules review will provide recommendations on how to handle defined holiday periods e.g. first May Day Bank Holiday
 - Prepayment profile to utilise Class 3 data to bring model upto date
- **Reminder that DESC members will have the opportunity to review and influence the Modelling Approach in 2022**
- **In addition, results presented here can be used as an input/guide to UNC Workgroup 0754R which is looking into methods of improving the modelling performance.**
- **Reminder: Full detailed document will be published providing more results and commentary. This will then be used as DESC's Algorithm Performance Summary (Section 12 of the NDM Algorithms Booklet) which satisfies UNC Section H 1.8.1 (d)**