Demand Estimation Sub Committee

4.3 Algorithm Performance Gas Year 2021/22
Strand 3 – NDM Sample Analysis

13th December 2022

Contents

Background – Strand 3: NDM Daily Demand Analysis

- Supply Meter Point Demand Formula (NDM Algorithm) – Section H UNC 2.2.1

- Strand 3: NDM Sample Analysis is the key strand for assessing the performance of DESC's EUCs and Demand Models as it compares daily actual demand from the NDM sample with the estimated value from the NDM Algorithm

- Strand 3 results deliver the main conclusions for DESC which can be used in future approaches to Demand Modelling

- Key Point: AQ used in this analysis is NOT the AQ used in the core systems. This is because the analysis is focusing on the Demand Models and not changes in AQ levels (considered in Strand 2)

- NDM Daily Demand Analysis summary to be discussed under Agenda Item 4.3, with full set of results to be provided in Section 12 of the NDM Algorithms Booklet published in Summer 2023

Objective

- An evaluation of the NDM supply meter point formula is carried out every year
  - to assess the accuracy of the algorithms
  - identify any possible areas of improvement for future demand modelling
- This is done by comparing daily actual demands, with allocated demands produced by the NDM Algorithm
- Analysis is carried out on the Demand Estimation Sample supply meter points

Executive Summary

Objective 1 - To assess the accuracy of the algorithms

- Overall modelling error results (MAPE) for most EUCs are comparable with recent Gas Years.
- Unsurprisingly Domestic EUCs (01BND 01BPD, and 02BND) saw the biggest impacts due to the economy and unusually warm weather in Spring and Summer, yet are not significantly worse than previous years
- Modelling error results for I&C EUCs are comparable with Gas Year 2019/20. **Note:** Results for Gas Year 2020/21 not provided for majority of EUCs due to DESC decision not to update the models because of COVID impact

Objective 2 - Identify any possible areas of improvement for future demand modelling

- Areas of potential investigation have been identified to improve modelling approach

EUC	19-20 Winter	19-20 Summer	19-20 Year	20-21 Winter	20-21 Summer	20-21 Year	21-22 Winter	21-22 Summer	21-22 Year
01BND	4.8%	10.4%	7.6%	5.1%	11.0%	8.0%	6.5%	15.2%	10.9%
01BNI	7.3%	18.4%	12.8%				7.4%	34.2%	20.8%
01BPD	9.2%	26.6%	17.9%				**8.3%**	35.4%	21.9%
02BND	10.2%	29.5%	19.8%				**9.5%**	36.7%	23.1%
02BNI	10.0%	28.3%	19.2%				**9.7%**	28.6%	**19.2%**
03B	8.1%	19.7%	13.9%				**6.2%**	20.7%	**13.5%**
04B	6.8%	15.5%	11.2%				**4.4%**	**15.3%**	**9.9%**
05B	8.9%	20.4%	14.7%				**4.6%**	**12.4%**	**8.5%**
06B	10.3%	21.2%	15.8%				**6.8%**	**15.7%**	**11.3%**
07B	11.1%	22.4%	16.7%				15.1%	22.5%	18.8%
08B	14.0%	31.6%	22.8%				15.8%	**17.6%**	**16.7%**

Approach

Analysis has taken the following approach:

- Daily NDM consumption data obtained for Gas Year 2021/22
  - Validation applied – See 3.0 NDM Sample update slides for more information
- Calculate the Modelling Error using Actual and Allocated Energy
- Actual energy values use
  - NDM sample derived AQs
  - 2021/22 Weather Correction Factors (WCF)
- Two approaches to Allocation
  - MODEL: Allocated using 2021/22 ALPs and DAFs
    - All analysis shown is on this basis unless stated
  - RETRO: Allocated using 2022/23 ALPs and DAFs (adjusted for 2021/22 calendar) and 2022/23 Holiday Codes (following the Ad Hoc review in Winter 21/22)

Validated Sample Count

- The table below shows a breakdown of the sites that passed validation, spilt by EUC and LDZ, used for the Algorithm Performance analysis

EUC	SC	NO	NW	NE	EM	WM	WN	WS	EA	NT	SE	SO	SW	Total
01BND	586	620	647	628	684	568	408	434	613	646	620	633	644	**7,731**
01BNI	801	587	1,050	616	639	479	60	565	540	662	710	454	645	**7,808**
01BPD	308	307	659	337	392	312	99	132	224	211	317	125	115	**3,538**
02BND	21	20	19	16	15	16	3	3	15	33	32	12	11	**216**
02BNI	1,269	483	1,449	606	925	956	70	654	617	830	700	647	643	**9,849**
03B	892	180	455	247	375	351	38	210	332	424	380	278	277	**4,439**
04B	588	186	286	251	217	256	39	144	220	305	375	273	187	**3,327**
05B	196	88	115	111	96	114	13	43	76	129	128	96	46	**1,251**
06B	59	37	40	44	47	35	4	18	29	34	27	46	26	**446**
07B	21	10	14	21	25	19	1	2	6	7	13	6	8	**153**
08B	10	8	2	5	9	6	0	5	6	7	8	4	5	**75**
Total	**4751**	**2526**	**4736**	**2882**	**3424**	**3112**	**735**	**2210**	**2678**	**3288**	**3310**	**2574**	**2607**	**38,833**

Tests

- Assessments conducted by
  - Major EUCs for Consumption Bands 1 and 2 and ‘bucket’ bands for Consumption Bands 3-8
  - For all LDZs separately where sample data allowed, aggregated otherwise
  - Winter/Summer (October to March and April to September)
  - Month
  - Day of Week
  - Holiday Codes
- Mean Absolute Percentage Error (MAPE) is a measure of prediction accuracy of a forecasting method
  - It is calculated as Absolute(Model Energy-Actual Energy) / Actual Energy
  - The lower the MAPE value, the closer the prediction was to the actual value
- Mean Percentage Error (MPE) is a measure of the bias in the forecasting method
  - It is calculated as (Model Energy-Actual Energy) / Actual Energy
  - E.G. if MPE is -2% the model has under-allocated by 2%, if MPE is 2% the model has over-allocated by 2%

Analysis – Gas Year and Seasonal Error (MPE) by EUC

The table below shows the MPE (Mean Percentage Error) for the last 3 years by EUC

EUC	19-20 Winter	19-20 Summer	19-20 Year	20-21 Winter	20-21 Summer	20-21 Year	21-22 Winter	21-22 Summer	21-22 Year
01BND	-1.4%	-0.5%	-1.2%	0.7%	2.5%	1.2%	-3.7%	11.3%	-0.5%
01BNI	-3.5%	8.1%	-0.8%	.	.	.	-4.9%	18.7%	0.3%
01BPD	-4.7%	11.6%	-0.8%	.	.	.	-6.5%	25.4%	0.5%
02BND	-3.7%	8.4%	-0.6%	.	.	.	-3.4%	15.0%	1.4%
02BNI	-6.6%	18.0%	-0.5%	.	.	.	-5.0%	18.8%	1.3%
03B	-6.1%	15.7%	-0.5%	.	.	.	-3.3%	13.1%	1.4%
04B	-5.1%	12.4%	-0.4%	.	.	.	-1.6%	9.0%	1.6%
05B	-7.8%	18.0%	-0.1%	.	.	.	-0.1%	7.8%	2.6%
06B	-9.1%	18.6%	0.2%	.	.	.	-0.1%	10.1%	3.8%
07B	-8.2%	13.9%	0.4%	.	.	.	-1.1%	12.9%	4.7%
08B	-6.5%	11.5%	0.5%	.	.	.	5.5%	4.0%	4.8%

- Whilst overall the smaller EUCs have performed in line with the previous years, seasonally we can see the significance impact of the cost of energy on consumers behaviour.
- Note: only 01BND is shown for gas year 20-21, as the models were not updated for the other EUCs, due to the impact of Covid lockdowns.

Analysis – Gas Year and LDZ Error (MPE) by EUC

The table below shows the MPE (Mean Percentage Error) for Gas Year 2021/22 by LDZ

EUC	SC	NO	NW	NE	EM	WM	WN	WS	EA	NT	SE	SO	SW	Total
01BND	-0.6%	-1.0%	-0.4%	-0.6%	-0.8%	-0.7%	-0.6%	-1.1%	0.1%	-0.5%	-0.3%	-0.3%	0.1%	-0.5%
01BNI	0.1%	0.3%	0.3%	-0.4%	-0.0%	0.1%	0.1%	0.7%	0.6%	0.9%	0.5%	0.5%	0.8%	0.3%
01BPD	0.4%	0.4%	0.5%	0.3%	0.4%	0.6%	0.4%	0.8%	0.3%	0.2%	0.6%	0.6%	0.7%	0.5%
02BND														1.4%
02BNI	0.4%	1.6%	1.0%	0.9%	1.0%	1.6%	0.7%	1.7%	0.9%	1.6%	1.6%	2.1%	1.8%	1.3%
03B	0.4%	1.8%	1.1%	1.3%	1.4%	1.9%	0.9%	2.1%	1.3%	1.7%	1.8%	2.1%	2.3%	1.4%
04B	0.8%	1.4%	1.2%	1.5%	1.7%	1.8%	1.3%	2.1%	1.7%	1.5%	2.0%	2.1%	2.3%	1.6%
05B	1.9%	2.8%	2.1%	2.5%	2.9%	3.1%	1.8%	3.6%	2.4%	2.1%	2.9%	3.2%	3.4%	2.6%
06B														3.8%
07B														4.7%
08B														4.8%

- The MPE is consistently positive (and therefore over-forecast) for all LDZs in all EUCs except 01BND and 01BNI.
- Most LDZs follow a similar trend to the others in the EUC, however there are some outliers in Wales South and South West.

Analysis – Gas Year and LDZ Error (MAPE) by EUC

The table below shows the MAPE (Mean Absolute Percentage Error) for Gas Year 2021/22 by LDZ

EUC	SC	NO	NW	NE	EM	WM	WN	WS	EA	NT	SE	SO	SW	Overall
01BND	13.3%	12.3%	12.3%	12.7%	9.1%	9.6%	12.2%	10.5%	10.2%	10.0%	8.9%	10.5%	10.0%	10.9%
01BNI	15.8%	27.8%	26.9%	12.7%	15.7%	13.6%	13.6%	47.2%	12.7%	18.7%	17.7%	16.3%	22.3%	20.8%
01BPD	21.6%	16.8%	18.2%	18.0%	28.2%	19.9%	21.9%	26.6%	23.6%	25.8%	21.2%	25.8%	32.8%	21.9%
02BND														23.1%
02BNI	12.8%	12.9%	29.2%	9.5%	13.2%	17.7%	15.3%	49.2%	7.7%	22.0%	19.4%	13.3%	16.7%	19.2%
03B	11.2%	10.1%	15.5%	13.8%	10.4%	16.8%	8.7%	22.0%	12.4%	18.0%	10.7%	13.7%	11.2%	13.5%
04B	8.0%	10.5%	7.6%	12.5%	10.9%	12.2%	13.3%	9.2%	8.8%	9.4%	9.6%	12.1%	9.3%	9.8%
05B	6.3%	7.5%	9.1%	10.7%	8.7%	9.9%	16.1%	9.9%	8.5%	6.7%	7.7%	9.6%	9.8%	8.5%
06B														11.2%
07B														18.8%
08B														16.7%

- Generally, the individual LDZs show a similar MAPE to that of the EUC overall, however, Wales South has some quite significant MAPEs for ‘01BNI’ and ‘02BNI’.
- Where no breakdown is shown the sample count is insufficient for individual LDZ analysis.

Analysis – 01BND – Gas Year Time Series

EUC	SC	NO	NW	NE	EM	WM	WN	WS	EA	NT	SE	SO	SW	Total
01BND	586	620	647	628	684	568	408	434	613	646	620	633	644	7,731

- The chart on the right compares the aggregated view of daily actual demands, with the allocated demands produced by the NDM Algorithm
- Over the winter some under-allocation is apparent on the days with the highest demand as a result of unusually cold weather
- Energy prices began to rise in Q1 2022 and the change in consumer behaviour is clear, with almost every day from March onwards showing over-allocation
- This over-allocation was exacerbated by the abnormally warm weather over the summer

Analysis – 01BND - LDZ and Month Error (MPE)

The table below shows the MPE (Mean Absolute Percentage Error) for Gas Year 2021/22 by LDZ and Month

Month	SC	NO	NW	NE	EM	WM	WN	WS	EA	NT	SE	SO	SW
October	-9.9%	-9.4%	-9.3%	-8.5%	-8.5%	-6.2%	-10.7%	-12.6%	-2.7%	-9.2%	-11.8%	-11.0%	-4.1%
November	-7.2%	-5.6%	-4.4%	-7.1%	-5.1%	-5.1%	-2.8%	-4.9%	-3.0%	-4.5%	-4.1%	-4.4%	-5.2%
December	-5.3%	-4.2%	-6.6%	-7.4%	-3.5%	-4.1%	-8.1%	-3.9%	-6.0%	-5.7%	-2.8%	-4.5%	-6.0%
January	-6.1%	-5.7%	-3.1%	-3.4%	-4.2%	-4.4%	-2.5%	-6.3%	-4.2%	-3.4%	-1.7%	-2.3%	-4.2%
February	-3.4%	-5.0%	-6.3%	-5.1%	-3.7%	-3.3%	-3.9%	-2.6%	-4.0%	-3.5%	-1.2%	-3.5%	-2.3%
March	2.4%	0.7%	5.2%	6.1%	3.3%	3.9%	2.9%	2.7%	2.9%	2.4%	1.7%	3.3%	3.8%
April	3.3%	6.3%	6.8%	9.1%	7.9%	6.7%	7.6%	7.7%	6.9%	5.6%	3.5%	5.2%	9.7%
May	7.0%	3.5%	6.4%	6.1%	6.6%	6.2%	12.2%	7.6%	18.9%	9.7%	3.6%	6.1%	18.7%
June	23.4%	22.0%	20.3%	17.1%	8.5%	8.7%	11.1%	17.5%	7.7%	11.2%	6.7%	15.0%	7.7%
July	27.8%	17.0%	15.7%	13.0%	5.7%	7.5%	6.5%	8.5%	7.4%	13.4%	11.6%	11.0%	6.6%
August	22.2%	20.8%	17.6%	17.9%	3.9%	14.0%	7.2%	6.2%	17.3%	18.6%	15.1%	16.5%	9.2%
September	26.7%	22.4%	28.9%	28.7%	23.1%	18.2%	31.4%	22.1%	21.3%	21.5%	22.7%	22.3%	20.4%
Full Year	-0.6%	-1.0%	-0.4%	-0.6%	-0.8%	-0.7%	-0.6%	-1.1%	0.1%	-0.5%	-0.3%	-0.3%	0.1%

- This table clearly show the change in consumer behaviour across all LDZs as gas prices rose

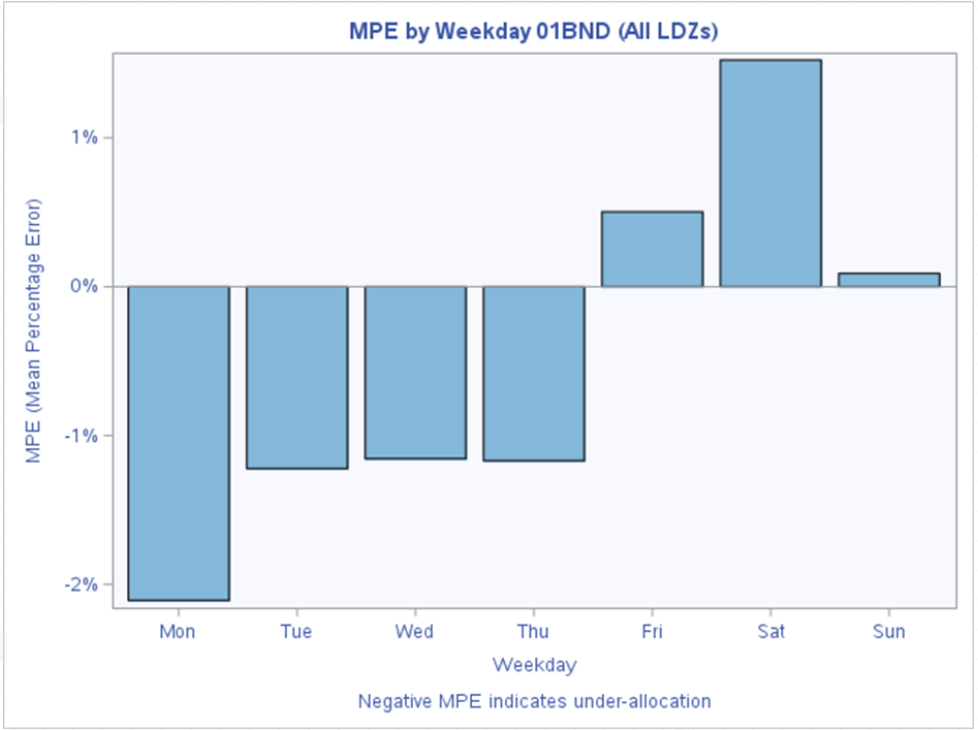
Analysis – 01BND – Day of Week Error (MPE)

- The chart below shows the modelling error (MPE - Mean Percentage Error) by day of week across the whole year for 01BND.

- There is an under-allocation for Monday to Thursday and an over-allocation for the weekend

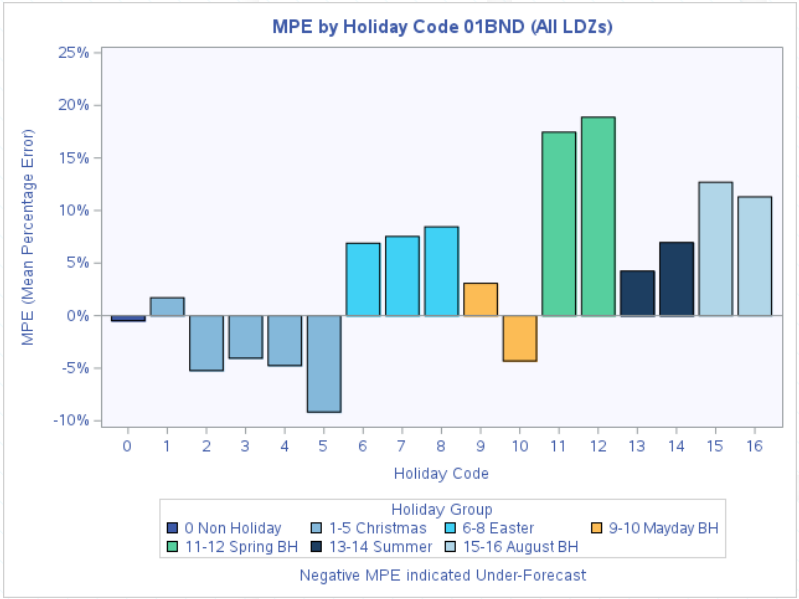
- Whilst these variances are fairly small, Monday is noticeably more under-forecast than the rest of the week, possibly a result of more working from home ?

- It may be worth considering forecasting Monday separately as currently Monday to Thursday are grouped for forecasting

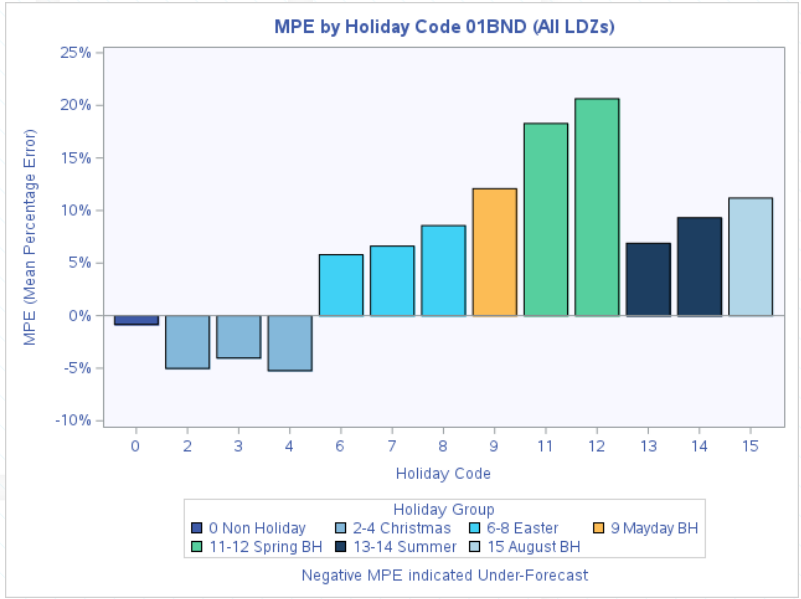


Analysis – 01BND – Holiday Error (MPE)

- The charts show the modelling error (MPE) by day of week across the whole year for 01BND
- The seasonal skews due to weather and cost of gas has clearly impacted the results, with the holidays showing similar results to the surrounding non holidays



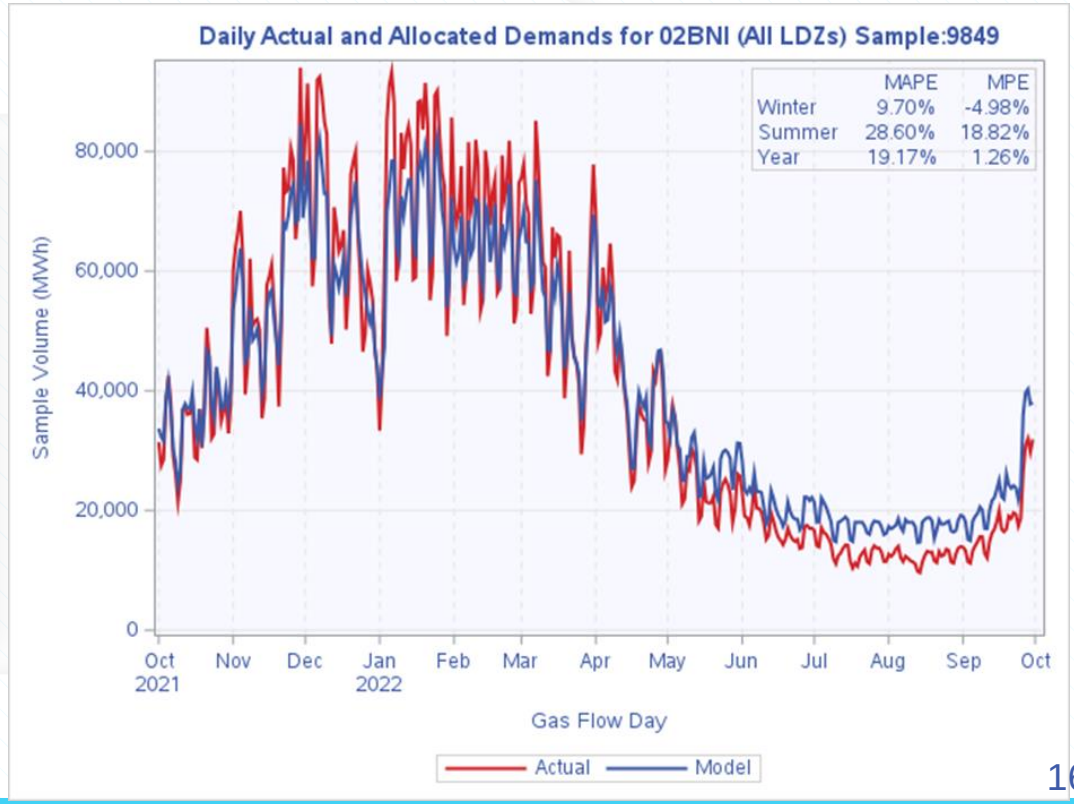
- The holiday codes changed at the beginning of the 22-23 gas year, if the new codes had been in place these would have been the results (calculated on a 'RETRO' basis)
- The results are similarly skewed by consumer behaviour relating to rising energy prices, however the variances for Christmas and New Year are slightly improved



Analysis – 02BNI – Gas Year Time Series

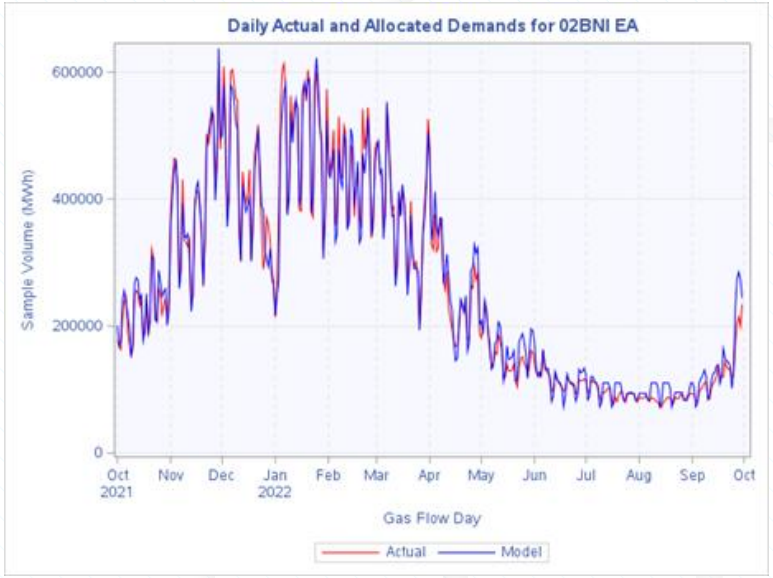
EUC	SC	NO	NW	NE	EM	WM	WN	WS	EA	NT	SE	SO	SW	Total
02BNI	1,269	483	1,449	606	925	956	70	654	617	830	700	647	643	9,849

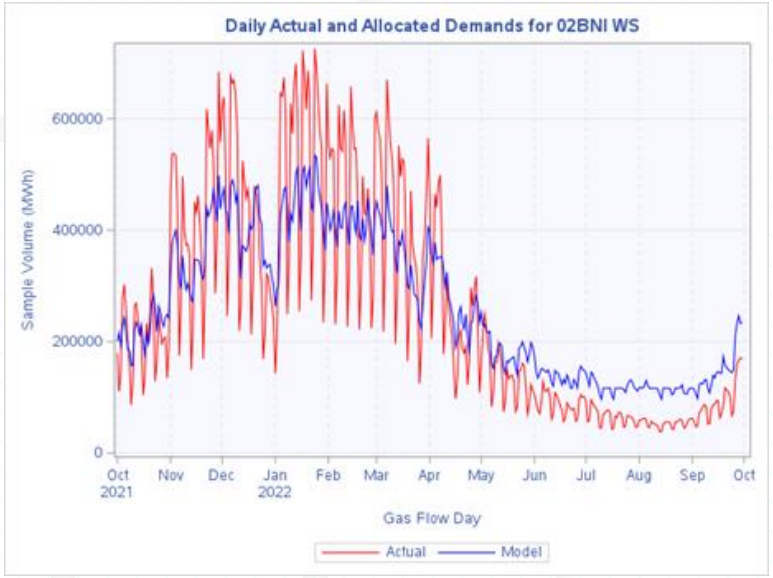
- The chart on the right compares the aggregated view of daily actual demands, with the allocated demands produced by the NDM Algorithm
- Over the winter there is both over-allocation and under-allocation, with a difference in consumption behaviour between weekdays and weekends
- There is overallocation from April onwards as businesses reduced their consumption because of rising energy costs
- This over-allocation was exacerbated by the abnormally warm weather over the summer



Analysis – 02BNI – Gas Year Time Series - EA and WS

The charts compare the aggregated view of daily actual demands, with the allocated demands produced by the NDM Algorithm for EA and WS

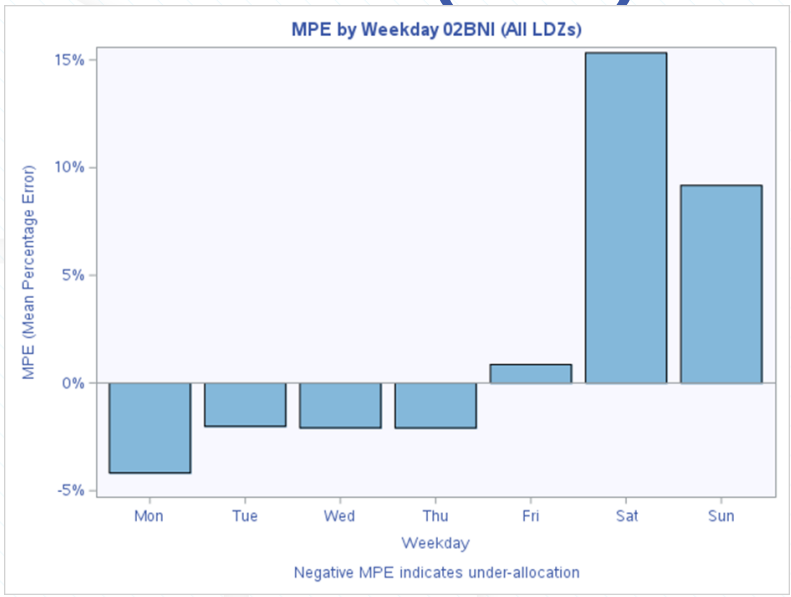




- Eastern consumption was in line with the forecast for most of the year, with just a small reduction over the summer
- Wales South by comparison consumption shifted significantly, with Weekdays largely under allocated and weekends over-allocated

Analysis – 02BNI – Day of Week Error (MPE)

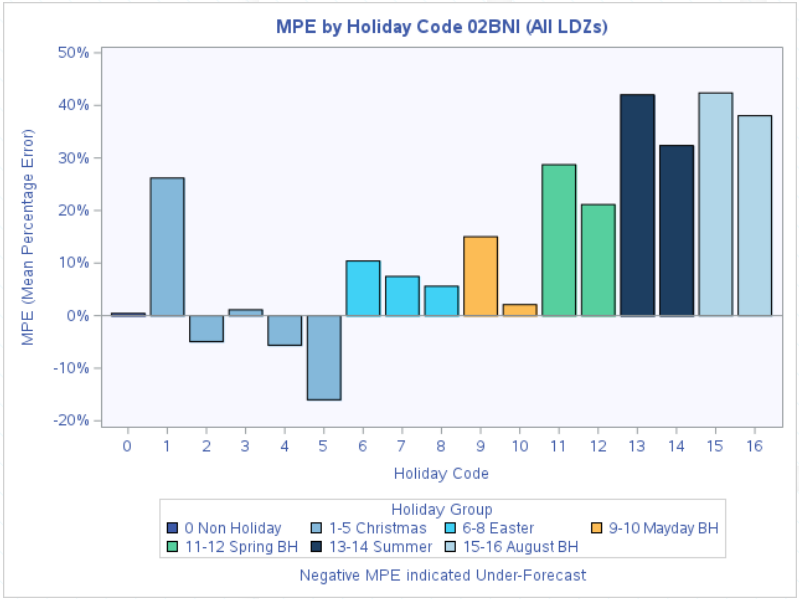
- The chart shows the modelling error (MPE - Mean Percentage Error) by day of week across the whole year for 02BNI
- The MPEs are small for weekdays, however there is a significant over-allocation on Saturdays and Sundays
- Whilst the weekend over-allocation is apparent for almost all LDZs, it is particularly prevalent for WS as shown on the previous slide



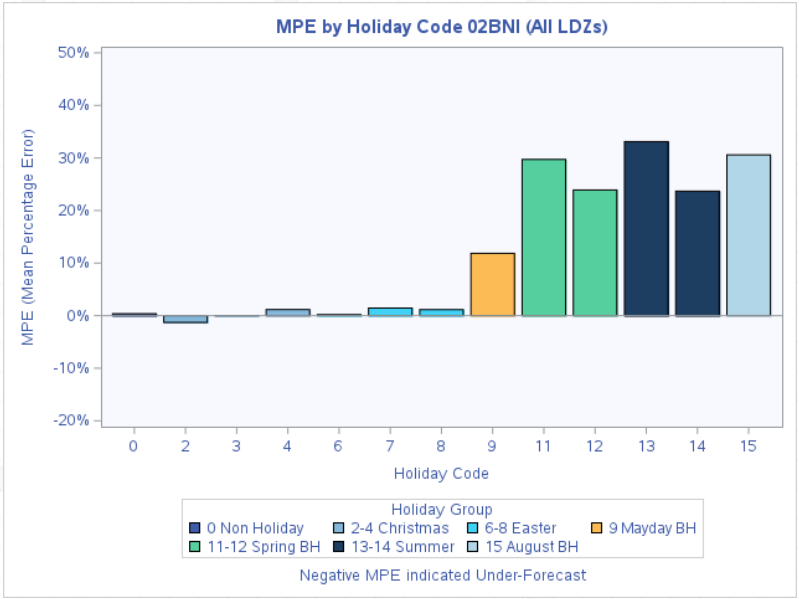
Weekday	SC	NO	NW	NE	EM	WM	WN	WS	EA	NT	SE	SO	SW
Mon	-5.2%	-0.1%	-8.6%	-0.0%	-1.7%	-4.2%	-1.9%	-14.1%	0.4%	-1.9%	-4.9%	0.5%	-2.2%
Tue	-3.1%	1.0%	-6.2%	0.8%	0.3%	-1.2%	-1.1%	-10.7%	2.1%	-0.7%	-1.8%	1.8%	0.4%
Wed	-2.1%	0.6%	-6.2%	-0.1%	0.4%	-0.7%	1.5%	-10.4%	2.0%	-1.4%	-2.4%	0.7%	-0.7%
Thu	-1.3%	0.1%	-5.8%	-0.2%	-0.5%	-1.1%	0.6%	-10.7%	2.2%	-1.3%	-3.3%	0.9%	-0.3%
Fri	-0.1%	1.6%	1.4%	1.2%	0.2%	0.3%	2.9%	1.6%	0.5%	1.4%	0.6%	0.1%	2.3%
Sat	13.1%	2.4%	34.4%	3.6%	5.0%	13.4%	1.2%	87.5%	-3.4%	11.0%	19.0%	5.8%	11.2%
Sun	7.7%	7.1%	15.5%	1.6%	5.3%	11.0%	2.7%	30.6%	1.2%	7.9%	11.4%	6.0%	4.7%

Analysis – 02BNI – Holiday Error (MPE)

- The charts show the modelling error (MPE) by day of week across the whole year for 02BNI
- The seasonal skews due to weather and cost of gas has clearly impacted the results, with the holidays showing over-allocation from May onwards, when this over-allocation was seen for all days



- The holiday codes changed at the beginning of the 22-23 gas year, if the new codes had been in place these would have been the results (calculated on a 'RETRO' basis)
- The MPEs are improved for all Holiday periods prior to May where there are significant over-allocations in line with the non-Holidays in the same period



Analysis – 02BNI – WS

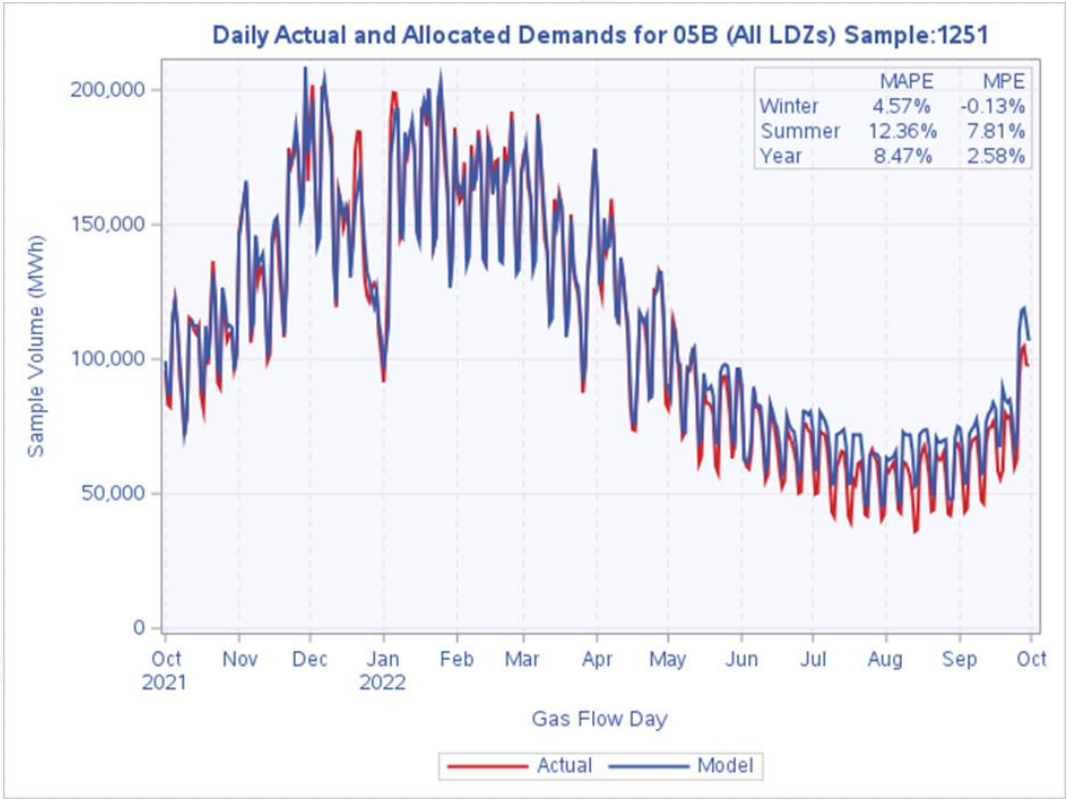
The results for Wales South are not as expected and worse than previous years

- There are a large number of sample meters with 0 consumption on Saturdays
- Most of the Sample Meters have consumption on Sunday so the weekend does not fit with normal consumption trends
    - These have been investigated but there is no clear error or issue we can identify
    - A possible driver of this could be early working days putting Monday consumption into Sunday
- There are almost 3 times as many Sample Meters in the Algorithm Performance compared to the forecast
    - Lack of data is not an issue
    - Reducing the count using random sampling, however, did remove the problem
- We will continue to investigate and report back any finding to DESC

Analysis – 05B – Gas Year Time Series

EUC	SC	NO	NW	NE	EM	WM	WN	WS	EA	NT	SE	SO	SW	Total
05B	196	88	115	111	96	114	13	43	76	129	128	96	46	1,251

- The chart on the right compares the aggregated view of daily actual demands, with the allocated demands produced by the NDM Algorithm
- Winter daily actual and allocated demands were close, except for a couple of short cold snaps
- Summer shows an over-forecast across most periods from mid-April onwards



Analysis – 05B – LDZ and Month Error (MPE)

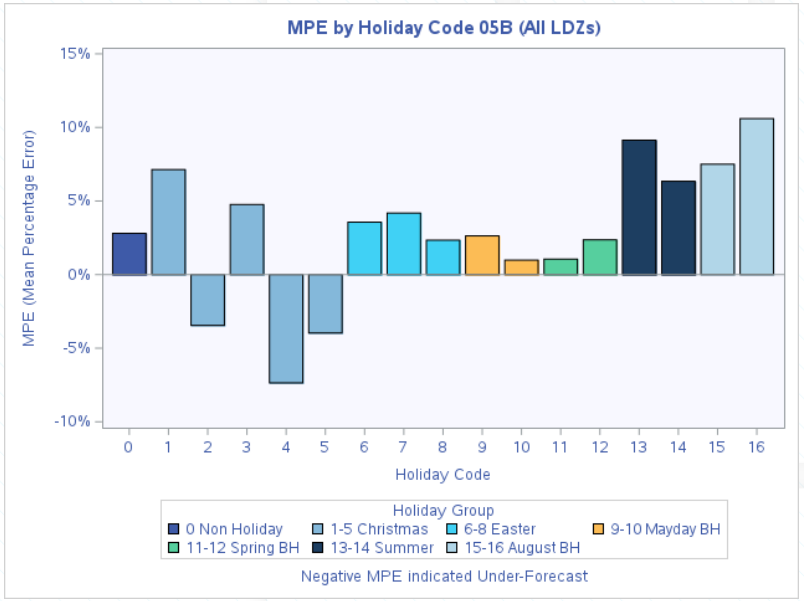
The table below shows the MPE (Mean Absolute Percentage Error) for Gas Year 2021/22 by LDZ and Month

Month	SC	NO	NW	NE	EM	WM	WN	WS	EA	NT	SE	SO	SW
October	-0.9%	0.9%	-0.6%	-1.1%	5.9%	10.9%	1.0%	4.8%	6.0%	1.7%	0.1%	-0.1%	2.7%
November	0.8%	3.9%	-0.4%	-0.6%	3.2%	2.6%	4.1%	7.7%	3.8%	0.7%	3.0%	-0.5%	-3.3%
December	1.4%	0.2%	-2.6%	0.3%	-1.1%	-5.0%	-9.5%	11.3%	-3.3%	-2.7%	-1.0%	-3.1%	-3.6%
January	-0.4%	2.1%	-0.3%	-1.7%	-1.6%	-4.1%	-4.6%	5.3%	-1.8%	-0.1%	0.3%	1.1%	-1.3%
February	-0.6%	0.2%	-4.3%	-3.0%	-1.7%	-4.2%	-3.1%	6.9%	-1.3%	-0.3%	-0.8%	-1.2%	1.7%
March	0.2%	-2.3%	-0.3%	-2.6%	1.6%	1.2%	-0.1%	2.0%	0.8%	0.8%	-2.2%	-1.1%	1.1%
April	-0.1%	2.1%	-3.7%	1.3%	4.6%	7.5%	-6.2%	-0.4%	1.2%	-0.6%	-1.2%	1.9%	8.8%
May	0.8%	2.7%	-0.1%	1.4%	2.9%	7.3%	0.6%	4.0%	0.5%	8.2%	13.0%	9.3%	12.5%
June	8.1%	9.1%	11.0%	10.8%	2.4%	7.6%	10.3%	-7.2%	5.5%	-2.0%	6.3%	7.7%	4.7%
July	12.4%	10.8%	14.9%	20.9%	11.3%	11.7%	22.2%	-3.7%	18.7%	15.1%	18.6%	20.3%	10.4%
August	7.0%	7.0%	19.1%	16.3%	13.3%	17.6%	25.1%	-4.0%	12.0%	18.9%	15.7%	28.0%	19.6%
September	8.1%	13.1%	23.8%	20.2%	11.9%	16.3%	27.4%	2.2%	10.4%	12.4%	10.7%	16.5%	13.2%
Full Year	1.9%	2.8%	2.1%	2.5%	2.9%	3.1%	1.8%	3.6%	2.4%	2.1%	2.9%	3.2%	3.4%

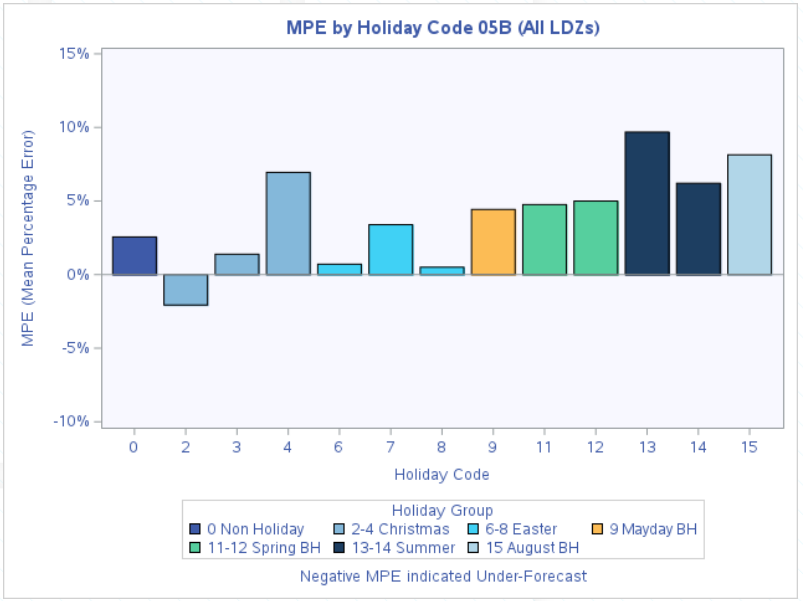
- The MPEs for 05B are less clear cut seasonally than the lower EUC bands
- Wales South in particular shows over-allocation in the winter and under allocation in the summer

Analysis – 05B – Holiday Error (MPE)

- The charts show the modelling error (MPE) by day of week across the whole year for 02BNI
- The seasonal skews due to weather and cost of gas has impacted the results, albeit to a lesser extend than with the more seasonal lower EUC bands



- The holiday codes changed at the beginning of the 22-23 gas year, if the new codes had been in place these would have been the results (calculated on a 'RETRO' basis)
- The MPEs for Christmas and Easter are slightly improved



Conclusions and Recommendations

Reminder of Objective

- to assess the accuracy of the algorithms
- identify any possible areas of improvement for future demand modelling

- Consumption behaviour for this gas year has been significantly impacted by abnormal weather and rising energy costs

- As a result, it is hard to draw any meaningful conclusions from this year's analysis however the following are suggested as future ad hoc workplan items
  - Separating Monday from the working week for domestic modelling
  - Treating 01BND as I&C for Weekend Factor modelling purposes

- Full supporting documentation will be published later in December