Post-Nexus Demand Response to Changes in CWV (°C)

Post-Nexus, the NDM allocation formula is changing to

$$\text{NDM Allocation} = \frac{\text{AQ}}{365} \times \text{ALP} \times \max(0.01, 1 + \text{DAF} \times \text{WCF}),$$

where the definition of AQ (Annual Quantity) and ALP (Annual Load Profile) are unchanged and DAF (Daily Adjustment Factor) and WCF (Weather Correction Factor) have new definitions.

AQ is the annual seasonal normal demand in kWh for a supply meter point. Each supply meter point is assigned to an EUC (End User Category). AQ is defined to relate to a standard 365-day year. The AQ is given by

$$\text{AQ} = \sum_{t=1}^{N} \text{SNDE}_t,$$

where SNDE_t is the Seasonal Normal Demand on day t for an EUC and N is the number days in a gas year ($N = 365$ for a non-leap year and $N = 366$ for a leap year).

ALP is the daily seasonal normal demand for the EUC for the day, as a proportion of the average daily seasonal normal demand for the EUC. Where the ALP is greater than 1 for a day, the EUC is expected to use more than its daily seasonal normal average demand, and vice versa where it is less than 1. The ALP on day t is given by

$$\text{ALP}_t = \frac{\text{SNDE}_t}{\frac{\sum_{t=1}^{N} \text{SNDE}_t}{N}} = \frac{N}{\text{AQ}} \times \text{SNDE}_t, \text{where} \sum_{t=1}^{N} \text{ALP}_t = N.$$

DAF on the day is the weather sensitivity of demand in the EUC as a proportion of the seasonal normal demand of the EUC. The DAF will always be equal to or less than zero, and represents the proportion of seasonal normal demand lost for an increase in CWV of 1°C, expressed as a decimal. For example, if the EUC were to lose 10% of its demand with an increase of 1°C in CWV, the DAF would be -0.1.

$$\text{DAF}_t = \frac{\text{WVCE}_t}{\text{SNDE}_t},$$

where WVCE_t is the Weather Variable Coefficient in the Demand Model for the EUC which can be thought of as the sensitivity to weather.

WCF on day t is given by

$$\text{WCF}_t = \text{CWV}_t - \text{SNCWV}_t,$$

where CWV is Composite Weather Variable for the LDZ for the day; and SNCWV is the Seasonal Normal value of the Composite Weather Variable for the LDZ for the day.

At the 1st February 2011 DESC meeting, it was agreed that in the application of the formula for 2011/12 onwards, the value of [1 + (DAF * WCF)] should be constrained to be not less than 0.01, in order to prevent negative allocations arising on warm days. This constraint will be retained under the Modification 0432 arrangements, to continue to prevent negative NDM Allocations.

Substituting these definitions into the NDM Allocation formula gives,

$$\text{NDM Allocation}_t = \text{SNDE}_t + \text{WVCE}_t \times (\text{CWV}_t - \text{SNCWV}_t),$$

assuming that $1 + \text{DAF} \times \text{WCF} \geq 0.01$.

Analysis

The analysis presented uses complete actual data for gas year 2015/16. XoServe provided DAFs calculated under the new definition for gas year 2015/16 and the AQs and ALPs are the same as what would have been used pre-Nexus. The WCF is calculated using actual CWV and the defined SNCWV for each day.

There are thirteen LDZs each with up to thirty-three EUCs giving a total of 429 profiles. Gas year 2015/16 has 366 days giving 157,014 calculations of $\max(0.01, 1 + \mathrm{DAF} \times \mathrm{WCF})$. Looking at this calculation, only 88 (0.06%) results were equal to 0.01 meaning that for 99.94% of calculations this term evaluates as $1 + \mathrm{DAF} \times \mathrm{WCF}$. To analyse the demand response to changes in CWV it is assumed that $\max(0.01, 1 + \mathrm{DAF} \times \mathrm{WCF}) \geq 0.01$ in all cases.

As $\mathrm{WCF_t} = \mathrm{CWV_t} - \mathrm{SNCWV_t}$, the NDM Allocation formula becomes

$$\mathrm{NDM_1} = \frac{\mathrm{AQ}}{365} \times \mathrm{ALP}_t \times (1 + \mathrm{DAF}_t \times [\mathrm{CWV}_t - \mathrm{SNCWV}_t]).$$

If the CWV changes by β the NDM Allocation is then

$$\mathrm{NDM_2} = \frac{\mathrm{AQ}}{365} \times \mathrm{ALP}_t \times (1 + \mathrm{DAF}_t \times [\mathrm{CWV}_t + \beta - \mathrm{SNCWV}_t]),$$

and the change in NDM Allocation for a change in CWV by β is

$$\mathrm{NDM_2} - \mathrm{NDM_1} = \Delta\mathrm{NDM_t} = \frac{\mathrm{AQ}}{365} \times \mathrm{ALP_t} \times \beta \times \mathrm{DAF_t},$$

A demand response for a change in CWV by 1°C (β = 1°C) is then,

$$\Delta\mathrm{NDM}_t = \frac{\mathrm{AQ}}{365} \times \mathrm{ALP}_t \times \mathrm{DAF}_t = \frac{\mathrm{N}}{365}\mathrm{WVCE_t}.$$

The AQ for each EUC typically does not vary throughout the year in either absolute or percentage from average terms. For example, EUC band 01 (E01B) in EM has a maximum AQ of [removed], minimum AQ of [removed] and average AQ of [removed]. This gives a percentage difference from average of [removed] (minimum) and [removed] (maximum). To calculate the demand response a fixed AQ equal to the yearly average AQ is used to calculate the demand response for each EUC band in each LDZ.

The ALP and DAF profiles are used on a daily level and the results are given at a monthly granularity for each LDZ with the demand responses given per day for a 1°C change in CWV.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
EA												
EM												
NE												
NT												
NO												
NW												
SC												
SE												
SO												
SW												
WM												
WN												
WS												
National												

Demand responses per day for a 1°C change in CWV for each LDZ

[chart removed]

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
E01B												
E02B												

E03B												
E03W01												
E03W02												
E03W03												
E03W04												
E04B												
E04W01												
E04W02												
E04W03												
E04W04												
E05B												
E05W01												
E05W02												
E05W03												
E05W04												
E06B												
E06W01												
E06W02												
E06W03												
E06W04												
E07B												
E07W01												
E07W03												
E08B												
National												

Demand response per day for a 1°C change in CWV for each EUC, missing EUCs have no response.

[chart removed]

The minimal difference in the national results comes from the average AQs used in the calculations. This only creates a small discrepancy between the two views and the important interaction is between the ALP and DAF profiles when calculating the demand response to change in CWV as given by ΔNDM. In general, there is a [removed] demand response in winter and a [removed] demand response in summer for a 1°C change of CWV.

Looking at EUC bands individually there are four demand response profiles that appear when changing CWV. One is flat throughout winter with a reduced response in summer, the same as the national profile. The second is the same as the first demand response with an additional reduction in December. The third is a demand response profile that reduces around holiday periods. The fourth demand response profile is relatively flat throughout the year.

In nearly all EUC bands there are inbuilt holiday reductions in December and summer for industrial shutdown and school holidays in the ALPs. All base (B) and WAR01 to WAR03 EUC bands have a DAF profile that is seasonal with weekend effects whereas WAR04 band EUCs have a markedly different summer profile which cannot be regarded as seasonal. The different combinations of these ALP and DAF profiles create the different demand responses.

The same analysis has been completed looking at the days of the week to assess the demand response for changes in CWV. Making no allowance for the XoServe holiday definitions the LDZ responses across the week are,

LDZ	Mon	Tue	Wed	Thu	Fri	Sat	Sun
EA							
EM							
NE							
NT							
NO							

NW							
SC							
SE							
SO							
SW							
WM							
WN							
WS							
National							

[chart removed]

The demand responses for each EUC band are,

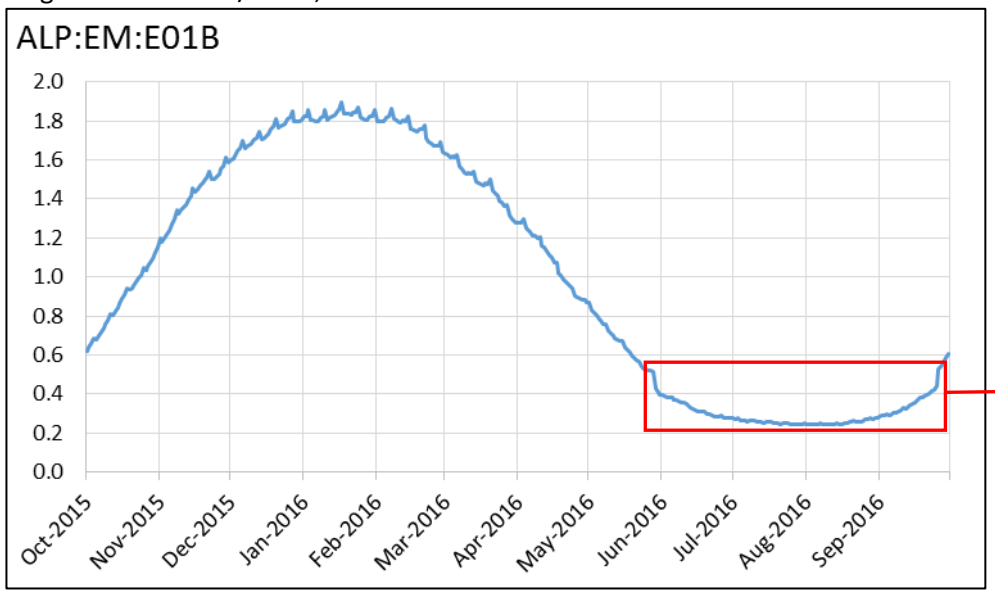
EUC	Mon	Tue	Wed	Thu	Fri	Sat	Sun
E01B							
E02B							
E03B							
E03W01							
E03W02							
E03W03							
E03W04							
E04B							
E04W01							
E04W02							
E04W03							
E04W04							
E05B							
E05W01							
E05W02							
E05W03							
E05W04							
E06B							
E06W01							
E06W02							
E06W03							
E06W04							
E07B							
E07W01							
E07W03							
E08B							
Total							

[chart removed]

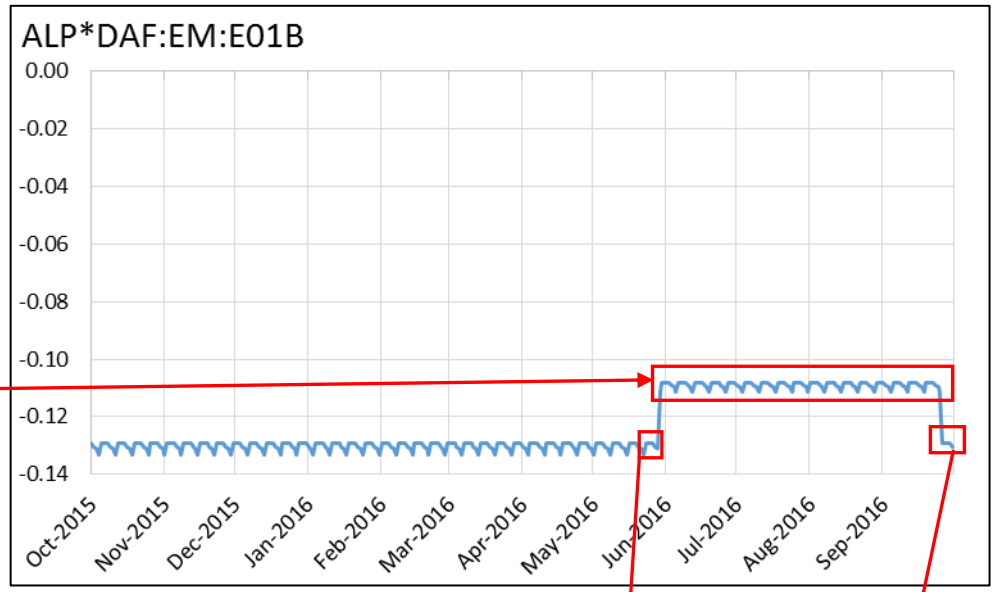
Demand Response Profiles – The demand response charts show the daily average demand response for each month using the formula for ΔNDM for the EUC used.

Demand Response Profile 1 – EM:E01B

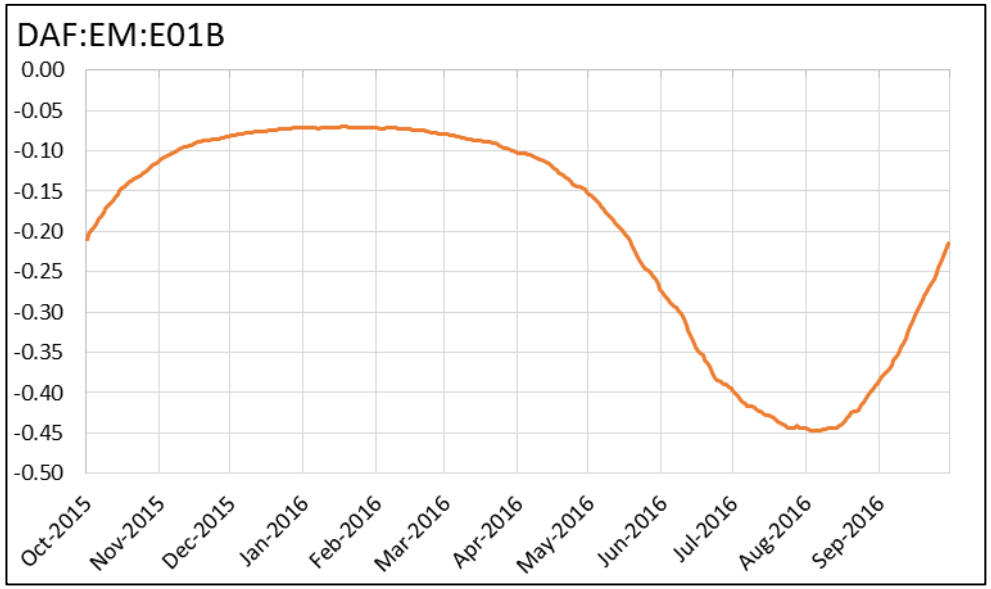
Large seasonal & W/E ALP, with a summer reduction but no December reduction



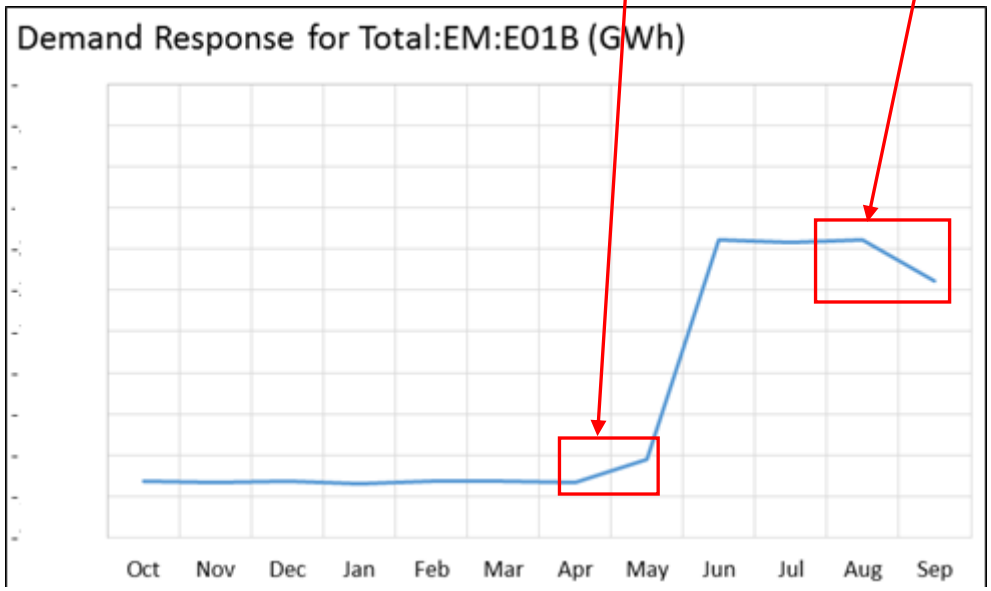
Interaction of ALP and DAF



Seasonal DAF



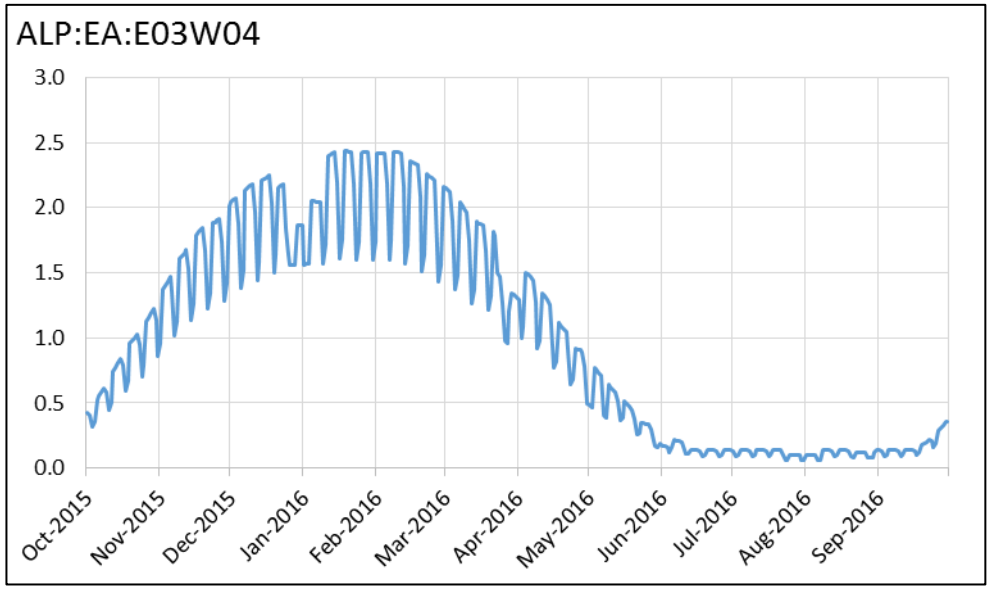
ΔNDM



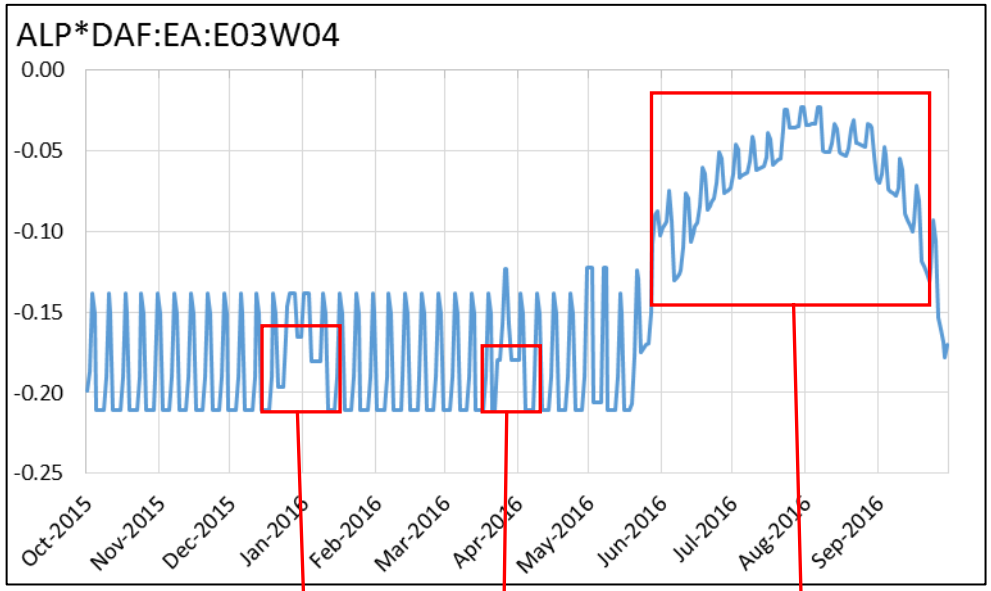
Flat demand response throughout the year, with a step change from winter to summer, range is 0.6GWh between maximum and minimum demand responses.

Demand Response Profile 2 – EA:E03W04

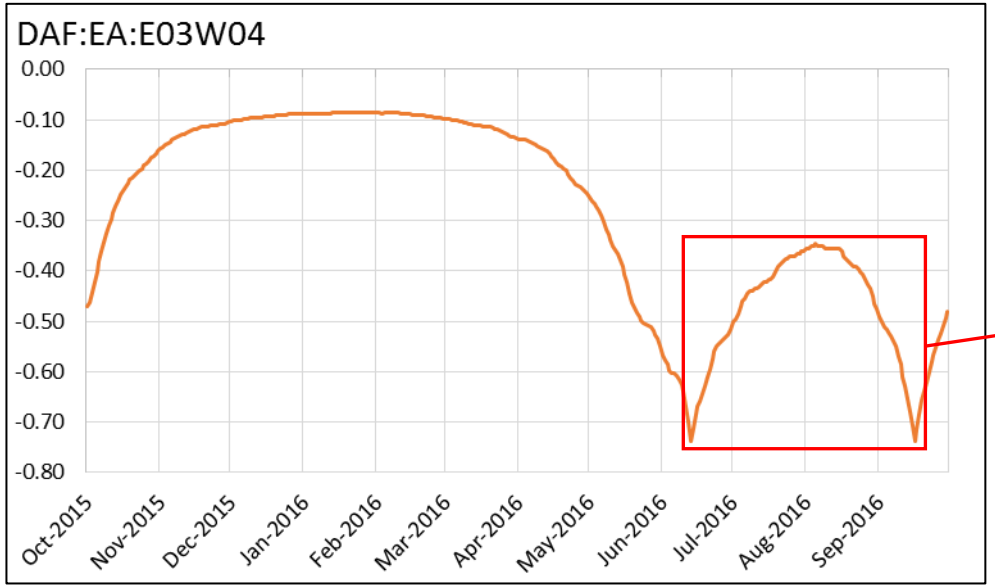
Large seasonal & W/E ALP, with a summer reduction and December reduction



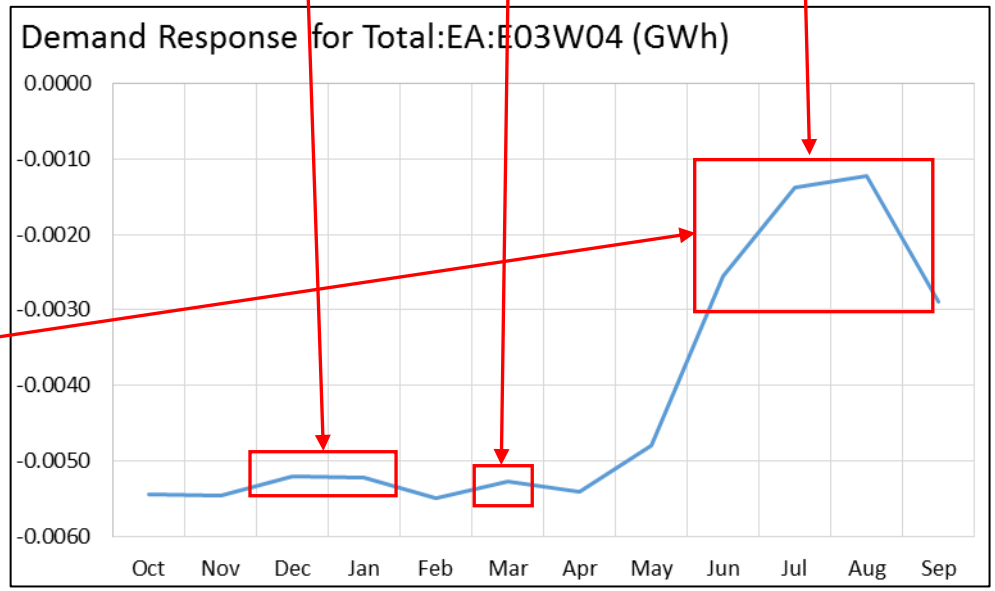
Interaction of ALP and DAF



Non–seasonal DAF



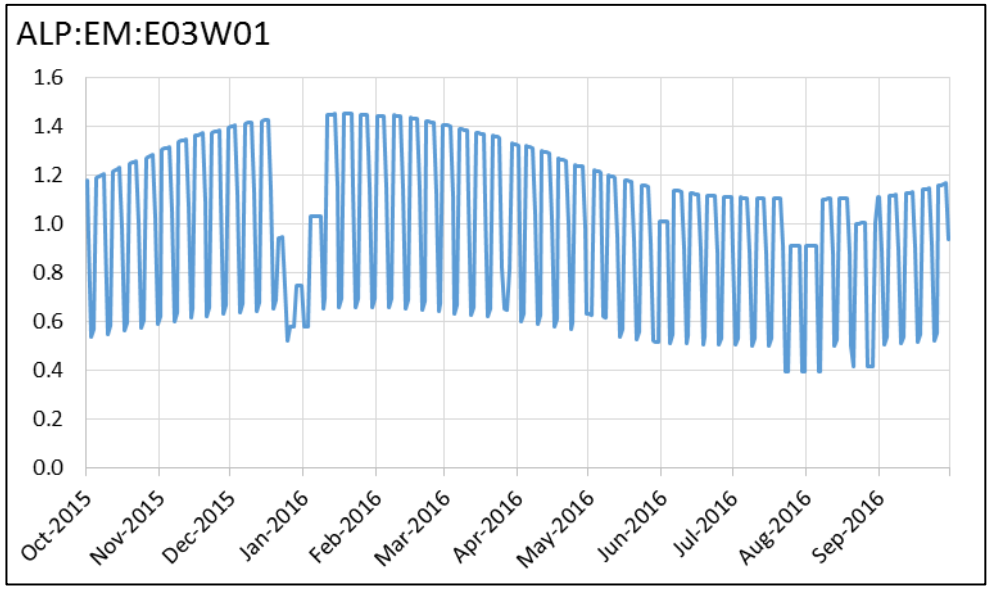
ΔNDM



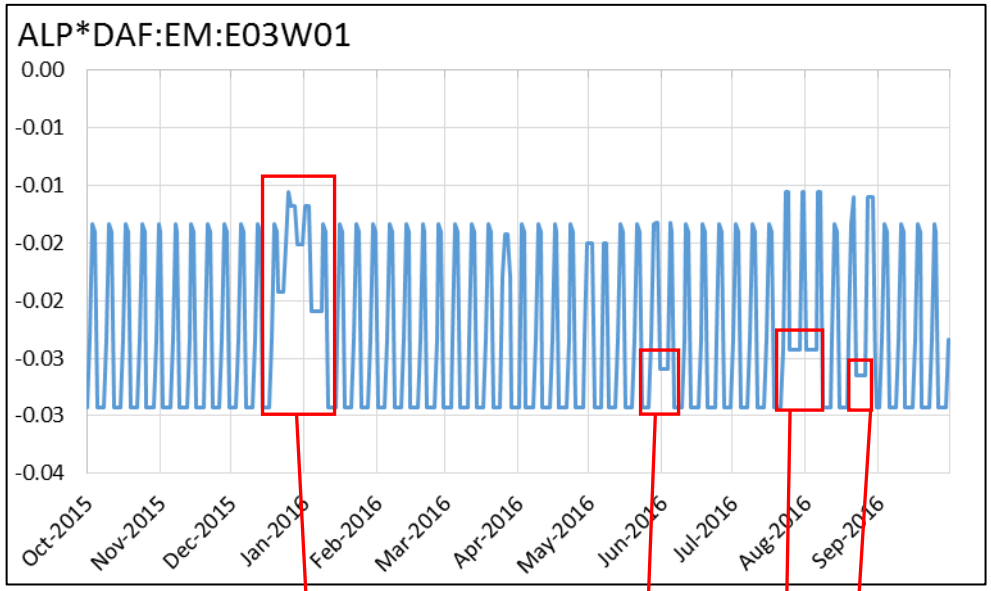
Flat demand response throughout winter with slight reductions in holidays and then a large demand response reduction in summer due to the DAF profile.

Demand Response Profile 3 – EM:E03W01

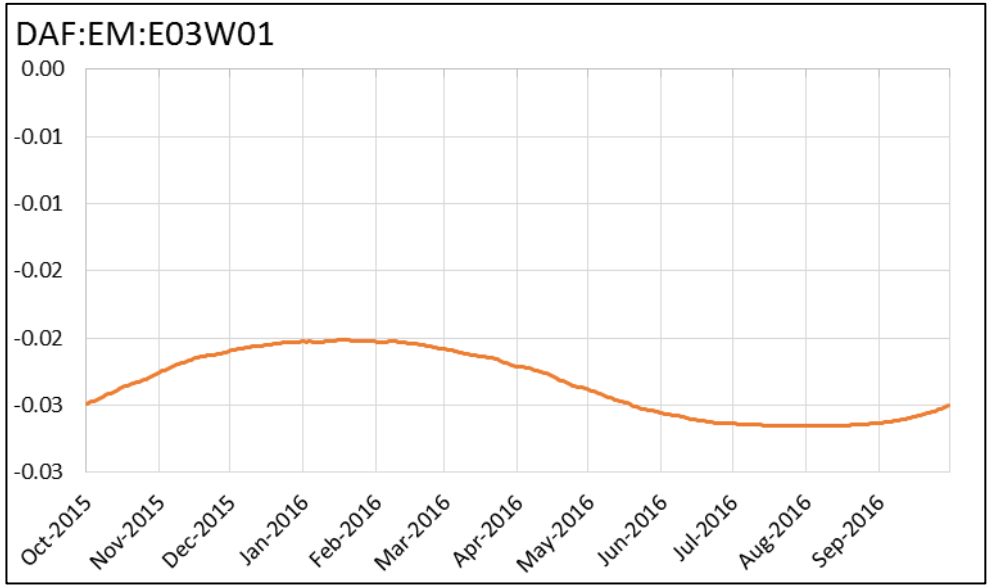
Small seasonal & W/E ALP with a summer reduction and a December reduction



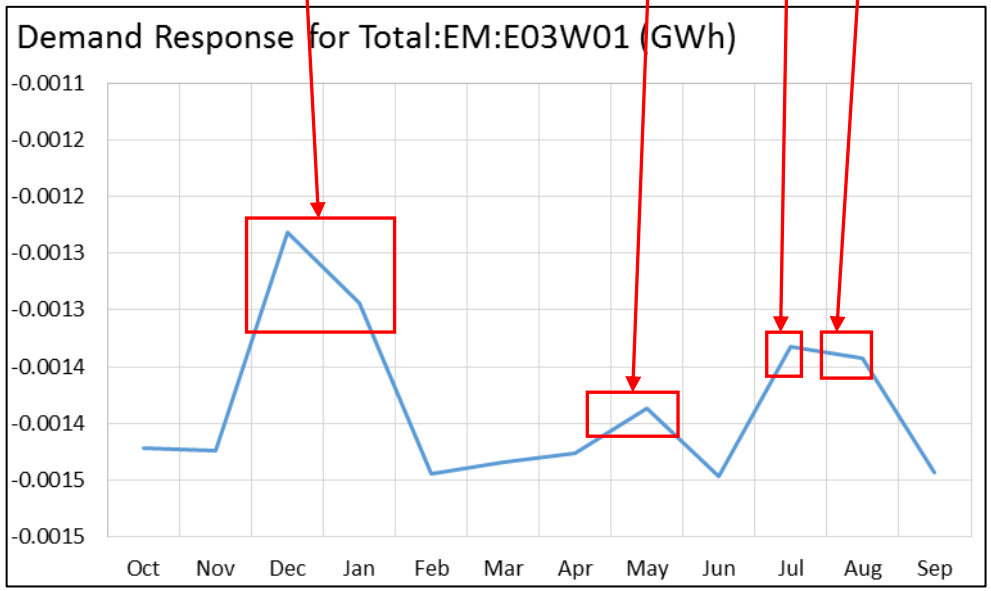
Interaction of ALP and DAF



Seasonal DAF



ΔNDM



Reduced demand response throughout the year during the holiday periods.