



METHODOLOGY

Dispatchable Load Portfolio Baseline Calculation

Version 1.0
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1 Introduction

The Methodology is intended to set out the details of the method for calculating the Demand Response Baseline. The Demand Response Baseline quantifies load reductions during a Demand Response Event and is necessary for calculating the remuneration of participants in the Demand Response programs and evaluating their performance.

2 Definitions

The necessary definitions for calculating the Demand Response Baseline are provided below:

Public Holidays: The following shall be Public Holidays: New Year's Day, Epiphany, Clean Monday, Annunciation, Orthodox Good Friday, Orthodox Holy Saturday, Orthodox Easter Sunday, Orthodox Easter Monday, Labour Day, Orthodox Whit Monday, Assumption, Ochi Day, Christmas Day, Boxing Day.

Initial Demand Response Baseline (Unadjusted Baseline): An initial estimate of the electricity that would have been consumed by the consumer in the absence of a Demand Response Event prior to any adjustment.

Demand Response Baseline Adjustment: A fixed quantity in MW, which is added to or deducted from the Initial Demand Response Baseline in order to calculate the Demand Response Baseline.

Look-Back Window: The range of days prior to the Demand Response Event day which are considered in identifying the days for a Demand Response Baseline Window. The Look-Back Window shall be the forty-five days that precede the Demand Response Event day.

Notification: The communication with the Demand Response Aggregators to notify them of an upcoming Demand Response Event before the Event occurs.

Demand Response Event: The time periods and transitions during which the HETS Operator issues Dispatch Instructions for the activation of Demand Response.

Demand Response Baseline (DRB): An estimate of the electricity that would have been consumed by the consumer in the absence of a Demand Response Event.

Demand Response Aggregators (DRA): The Dispatchable Load Portfolios which include one or more Loads which are connected to a specific Bidding Zone and which, based on their technical capacity, offer Balancing Services to the HETS Operator.

Demand Response Baseline Window: The days which are selected from the Look-Back Window and which are used to calculate the Demand Response Baseline.

Adjustment Window: The 15-minute intervals which are selected to calculate the fixed quantity for adjustment of the Demand Response Baseline.

3 Demand Response Baseline

Demand response programs rely upon incentivizing consumers to reduce their consumption and therefore a reliable system to measure consumption reduction is required. For this reason, the measurement and verification of Demand Response is the most critical component of any program. The Demand Response Baseline is the primary tool for measuring load curtailment during a program.

“The Demand Response Baseline is an estimate of the electricity that would have been consumed by the consumer in the absence of a Demand Response Event”

The Demand Response Baseline is presented in Figure 1. The Actual Load in Figure 1 is the actual meter data from the period of the Demand Response Event.

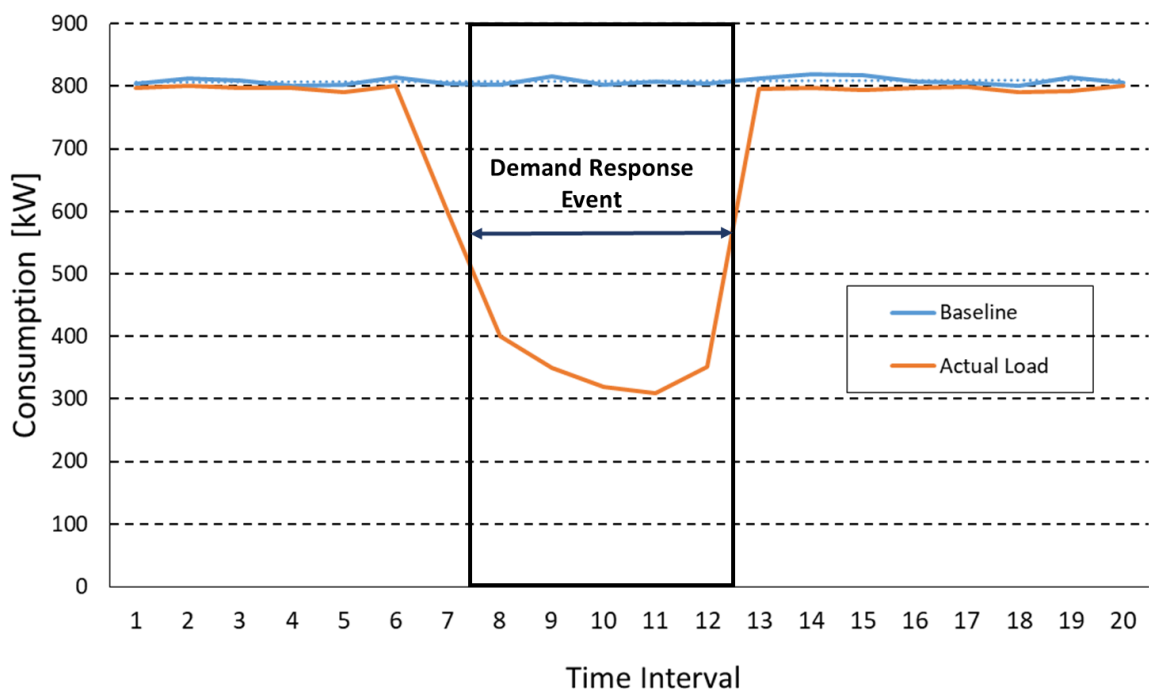


Figure 1 Demand Response Baseline

During the execution of a Demand Response Program the Demand Response Aggregators shall reduce their demand in response to a Dispatch Instruction by the HETS Operator. Typically, the instruction to reduce demand refers to a specific time interval within a specific day. The Demand Response Event. Figure 2 shows the timing of a Demand Response Event:

- the time when the Demand Response Aggregator receives a notification from the HETS Operator,
- the start time of the Dispatch Instruction (Occurrence of Demand Response Event), and
- the end of the Demand Response Event, which is specified in the Dispatch Instruction of the HETS Operator and which is followed by the return of the Demand Response portfolio to normal operation.

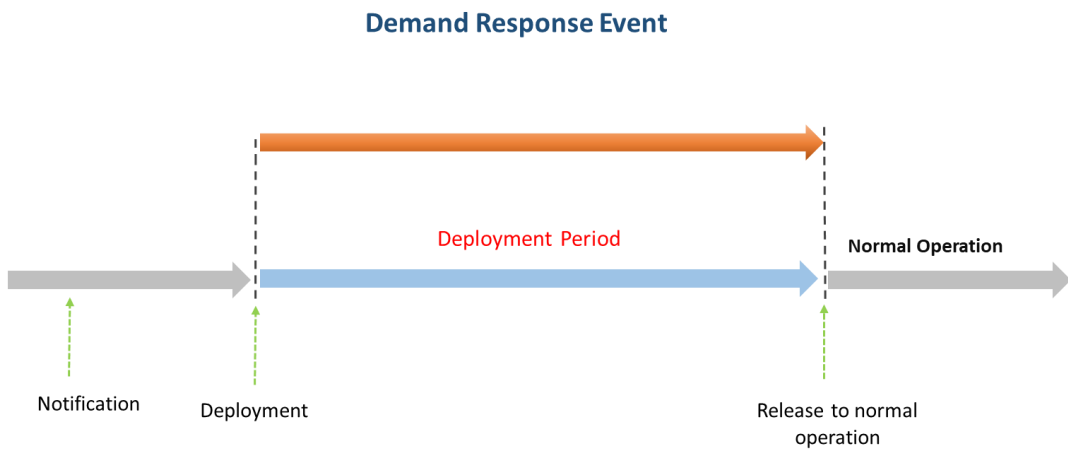


Figure 2 *Timing of Demand Response Event*

4 Demand Response Baseline Calculation Methodology

The method used for calculating the Baseline is the *High X of Y method* which considers the eligible Y days and selects the X days with the highest load to calculate the Demand Response Baseline on the basis of the most recent meter readings for consumption levels within those days. Furthermore, for the calculation of the highest consumption the *Averaging Method* is used, as specified below:

When a Demand Response Event occurs during a weekday, the *High 5 of 10 method* is used, whereby the 5 (X) days with the highest average consumption in the hours corresponding to the duration of the Demand Response Event are selected among the 10 (Y) most recent eligible weekdays.

When the Demand Response Event occurs on a Saturday, Sunday or public holiday, the same method is used, but this time for the *High 2 of 3*.

Dispatch Day D starts at 01:00 Eastern European Time of calendar day D and ends at 01:00 Eastern European Time of calendar day D + 1. The time interval used for the calculation shall be set as 15-minute intervals, commencing with 01:00 – 01:15 and with the next intervals following sequentially without overlapping.

5 Determination of Demand Response Baseline Window

In order to determine the Demand Response Baseline Window, the Look-Back Window should first be determined, which consists of the forty-five (45) most recent days preceding a Demand Response Event day. The Demand Response Baseline Window shall then be determined separately for:

- Weekdays.
- Saturdays.
- Sundays and public holidays.

5.1 Determination of Demand Response Baseline Window for weekdays

The Demand Response Baseline Window is defined as the ten (10) most recent days within the Look-Back Window which are not excluded as described in the rules below. The following days shall be excluded from the Baseline Window days, when determining a Demand Response Event that occurs on a weekday:

- A day prior to the Demand Response Event.
- Demand Response Event days.
- Weekends.
- Public Holidays.
- Days with generation outages or force majeure events.

In the event that, when searching for qualifying days within the Look-Back Window, the required number of ten (10) days cannot be reached, and if at least five (5) days have been found for the calculation of the Demand Response Baseline, then, instead of ten (10) days, the number of days found shall be used. In the event that the required number of five (5) days cannot be reached, the Baseline shall be determined by using not only the days which fulfill the conditions, but also Demand Response Event days with the higher meter reading average, until the requisite five (5) days are reached.

Table 1 presents an example of the calculation of the Baseline Window for weekdays in the form of a calendar. The Baseline Window was selected based on two Demand Response Events, on 13/01 and on 5/01 respectively, as shown in Table 1 in blue. The calendar view illustrates the order of selection of the ten (10) days for the Baseline Window, starting two (2) days prior to the Demand Response Event. As shown here, the days excluded are the day preceding the day on which the Demand Response Event occurred (in gray), public holidays (in green) and weekends (in blue).

Table 1. Determination of the Demand Response Baseline Window for weekdays

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
19-Dec	20-Dec	21-Dec	22-Dec	23-Dec	24-Dec	25-Dec
26-Dec	27-Dec	28-Dec	29-Dec	30-Dec	01-Jan	02-Jan
03-Jan	04-Jan	05-Jan	06-Jan	07-Jan	08-Jan	09-Jan
10-Jan	11-Jan	12-Jan	13-Jan			

Day without a Demand Response Event	Demand Response Event Day	Weekend	Prior to Event Day	Public Holiday
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Table 2 presents the ten-day Demand Response Baseline Window for those two Demand Response Events.

Table 2. Demand Response Baseline Window for weekdays

Demand Response Event	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
13/01	11/01	10/01	7/01	4/01	3/01	30/12	29/12	28/12	27/12	23/12
5/01	3/01	30/12	29/12	28/12	27/12	23/12	22/12	21/12	20/12	19/12

5.2 Determination of the Demand Response Baseline Window for Saturdays and for Sundays & Public Holidays

The method for determining the Baseline Window for Saturdays and for Sundays or Public Holidays is similar to the one used for weekdays.

The Window for a Demand Response Event that occurs on a Saturday shall include the three most recent Saturdays. The following days shall be excluded from the Window:

- Days of Demand Response Events.
- Weekdays.
- Sundays and Public Holidays.
- Days of generation outages or force majeure events.

The Window for a Demand Response Event that occurs on a Sunday or Public Holiday shall include the three most recent Sundays or public holidays. The following days shall be excluded from the Window:

- Days of Demand Response Events.
- Saturdays and weekdays.
- Days of generation outages or force majeure events.

The procedure to be followed when the required days are not reached is similar to the one used for weekdays, the only difference being that the required number shall be two (2) days instead of five (5) days. Table 3 shows, in the form of a calendar, an example of the calculation of the Demand Response Baseline Window for a Demand Response Event (in blue) which occurred on Saturday 02/02 (Sundays are a similar case).

Table 3. Baseline Calculation Window for Weekends and Public holidays

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
07-Jan	08-Jan	09-Jan	10-Jan	11-Jan	12-Jan	13-Jan
14-Jan	15-Jan	16-Jan	17-Jan	18-Jan	19-Jan	20-Jan
21-Jan	22-Jan	23-Jan	24-Jan	25-Jan	26-Jan	27-Jan
28-Jan	29-Jan	30-Jan	31-Jan	01-Feb	02-Feb	

Non-Demand Response Event Day	Demand Response Event Day	Weekend
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Table 4. The days used for calculating the Demand Response Baseline (Saturdays).

Demand Response Event Day	Day 1	Day 2	Day 3
02/02	26/01	19/01	12/01

6 Calculation of the Initial Demand Response Baseline

The Initial Demand Response Baseline (Unadjusted Baseline) shall be calculated for each 15-minute interval of the Demand Response Event day. The Initial Demand Response Baseline can also be calculated for an interval which is longer than a day if required for determining the Adjustment Window. For the calculation of the Initial Demand Response Baseline the following procedure shall be followed:

1. For each of the days within the Demand Response Window (10 days for a Demand Response Event on a weekday and 3 days for a Demand Response Event at a weekend or on a public holiday) the average meter readings for the Demand Response Aggregator i in the Bidding Zone z shall be calculated, taking into consideration only the hours of each of the above days that correspond to the hours of the Demand Response Event.
2. The days of the Baseline Window shall be ranked in descending order based on the above average meter readings.
3. The five (5) days with the highest average shall be selected for a Demand Response Event on a weekday, as opposed to two (2) days for a Demand Response Event at a weekend or on a public holiday.
4. For each 15-minute interval within a Demand Response Event day the Initial Demand Response Baseline in MW shall be calculated as the average of the corresponding 15-minute interval, t , of the days selected in the previous step.

The example of paragraph 5.1 is then considered for the Demand Response Event on 13/01. First the daily average consumption is calculated for the ten (10) days, taking into consideration the hours corresponding to those of the Demand Response Event (15:00 – 16:00). In Table 5, the sixth column contains the average consumption for each of the ten (10) days of the Demand Response Event time interval. The days are then ranked according to their average consumption, as indicated in the seventh column of Table 5. Finally, the five (5) days with the highest consumption are selected, as shown in Table 6. In the event of days with the same average consumption, those that are closer to the day of the Demand Response Event shall be selected.

The Initial Demand Response Baseline shall be calculated for each hour of the Demand Response Event day as the corresponding 15-minute interval average for the above 5 days, as indicated in Table 6. For example, the Initial Demand Response Baseline for 15:00 hours (corresponds to the time interval 15:00-15:15) is calculated as the average of the meter readings at 15:00 hours on each of the five days selected.

Table 5. The 10 (Y) highest days for the selection of the 5 (X) highest days for the calculation of the Demand Response Baseline (weekdays)

Day	15:00 [MW]	15:15 [MW]	15:30 [MW]	15:45 [MW]	Average [MW]	Rank
Day 1	6.3	7.7	6.2	7.3	6.88	1
Day 2	6.2	7.3	7.5	6.1	6.78	2
Day 3	7.8	7.1	6.0	4.5	6.35	3
Day 4	4.9	6.9	6.6	5.8	6.05	4
Day 5	4.9	6.7	5.0	7.0	5.90	6
Day 6	5.8	7.8	5.0	4.2	5.70	7
Day 7	5.3	7.3	6.6	4.5	5.93	5
Day 8	5.0	4.4	6.3	6.7	5.60	8
Day 9	6.5	4.1	4.3	5.3	5.05	10
Day 10	4.3	6.5	5.9	4.8	5.38	9

Table 6. The 5(X) highest days for the calculation of the Demand Response Baseline (weekdays).

Day	15:00 [MW]	15:15 [MW]	15:30 [MW]	15:45 [MW]	Rank
Day 1	6.3	7.7	6.2	7.3	1
Day 2	6.2	7.3	7.5	6.1	2
Day 3	7.8	7.1	6.0	4.5	3
Day 4	4.9	6.9	6.6	5.8	4
Day 7	5.3	7.3	6.6	4.5	5
Average	6.10	7.26	6.58	5.64	

7 Adjustment and Calculation of Demand Response Baseline

As the conditions on a Demand Response Event day may often differ from the conditions over the previous days which were used for the calculation of the Initial Demand Response Baseline, an adjustment of the Initial Demand Response Baseline (Unadjusted Baseline) is required. The method followed for adjusting the Initial Demand Response Baseline shall be the *Additive Adjustment* method.

In particular, the HETS Operator shall adjust the Initial Demand Response Baseline by using data from the timeframe prior to the Demand Response Event. This timeframe is called Initial Demand Response Baseline Adjustment Window, and has a three-hour duration ending at the time at which the HETS Operator sends the notification to the Demand Response Aggregators, as shown in Figure 3 (green square). In the event that no consumption has been recorded throughout the above Adjustment Window, the most recent three hours prior to the Demand Response Event when consumption was recorded shall be taken as Adjustment Window. The procedure to be followed is set out below:

1. The Adjustment Window shall be determined.
2. The average of meter readings for each 15-minute interval included in the Initial Demand Response Baseline Adjustment Window shall be calculated.
3. The average of loads that have been calculated as the Initial Demand Response Baseline of each 15-minute interval included in the Demand Response Baseline Adjustment Window shall be calculated.
4. The Baseline Adjustment shall be calculated as equal to the quantity calculated in the second step minus the quantity calculated in the third step. The quantity can be either positive or negative.
5. The Demand Response Baseline shall be calculated as the algebraic sum of the Initial Demand Response Baseline and the Demand Response Baseline Adjustment. The Demand Response Baseline calculated in the above manner cannot be less than zero.

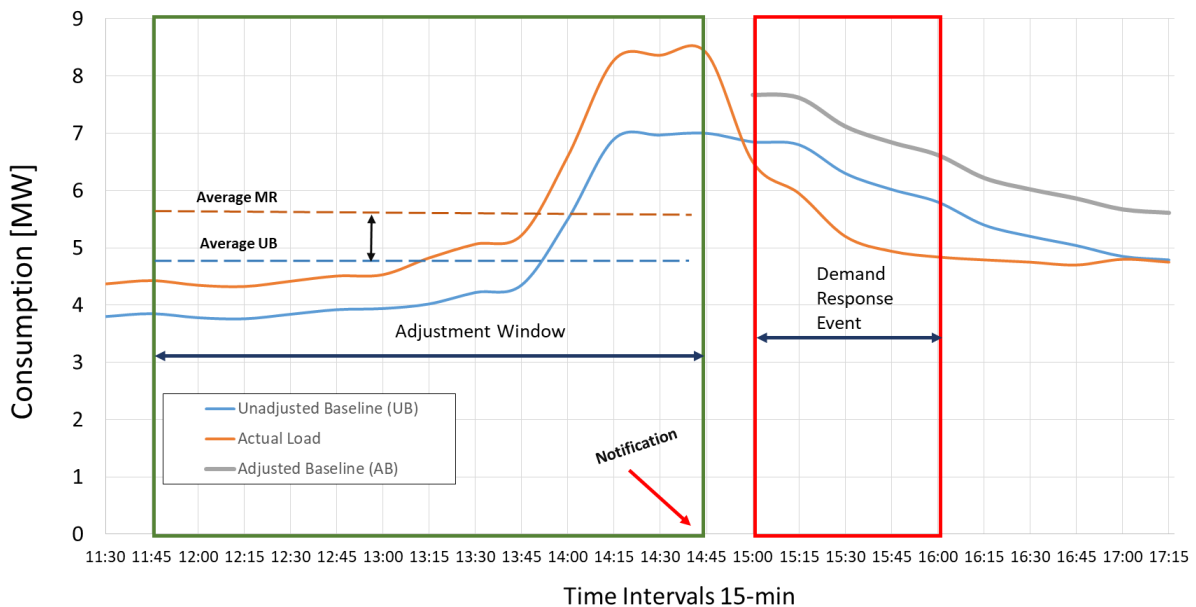


Figure 3 Adjusted Demand Response Baseline

The calculation of the Adjusted Demand Response Baseline is illustrated below, in mathematical relations (1) - (4).

$i \in I$	The Demand Response Aggregators
$t \in T$	The time interval within a dispatch day, 15 minutes.
$d \in D$	The X days with the highest average consumption which have been selected for the calculation of the Demand Response Baseline.
$d \in D1$	The day of the Demand Response Event.
N	The number of X days for the calculation of the Demand Response Baseline.
K	The number of the 15-minute intervals within the Adjustment Window.
$z \in Z$	The Bidding Zones where the Demand Response Aggregator portfolios belong.
$p_{z,i}^{t,d}$	The measured consumption for a Demand Response Aggregator portfolio i in Bidding Zone z during a 15-minute interval t of day d , in MW.
$bl_{z,i}^{t,init}$	The Initial Demand Response Baseline for a Demand Response Aggregator i during a time interval t in the Bidding Zone z , in MW.
$adj_{z,i}$	The Demand Response Baseline Adjustment for each Demand Response Aggregator portfolio i in the Bidding Zone z , in kW.
$bl_{z,i}^t$	The Demand Response Baseline for each Demand Response Aggregator i in Bidding Zone z , during time interval t .
$T^{str} (T^{end})$	The start (end time) of a Demand Response Event.
T^{not}	The time of notification of a Demand Response Event.
T_{adj}^{str}	The start time of an Adjustment Window.
T_{adj}^{end}	The end time of an Adjustment Window.

The Initial Demand Response Baseline, $bl_{z,i}^{t,init}$, is derived from mathematical relation (1) as the average of the corresponding 15-minute interval, t , of the X days selected (five days with the highest average for a Demand Response Event on weekdays or 2 days for a Demand Response Event at the weekend or on a public holiday).

$$bl_{z,i}^{t,init} = \frac{\sum_{d \in D} p_{z,i}^{t,d}}{N} \quad (1)$$

$i \in I, z \in Z, t \in [T^{str}, T^{end}]$

The Demand Response Baseline Adjustment is derived from mathematical relation (2) as the difference between the average consumption on an Event day and the average consumption of the Adjustment Window Baseline.

$$adj_{z,i} = \frac{\sum_{T_{adj}^{str}}^{T_{adj}^{end}} (p_{i,z}^{t,d})}{K} - \frac{\sum_{T_{adj}^{str}}^{T_{adj}^{end}} (bl_{z,i}^{t,init})}{K} \quad (2)$$

$i \in I, z \in Z, d \in D1, t \in [T_{adj}^{str}, T_{adj}^{end}]$

where:

$$T_{adj}^{str} = T^{not} - K * 15min$$

$$T_{adj}^{end} = T^{not}$$

The Demand Response Baseline is derived from mathematical relations (3) and (4):

$$bl_{z,i}^t = bl_{z,i}^{t,init} + adj_{z,i} \quad (3)$$

$$bl_{z,i}^t = \max(bl_{z,i}^t, 0) \quad (4)$$

$$i \in I, z \in Z, t \in T$$