CRM Design Note: Baseline design

August 2024

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1 Introduction

1.1 Context and goal of this design note

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The goal of this present note is to further clarify the current design of the baseline methodology applied in the Availability Obligation in the Belgian CRM. It provides the background for the existing design and elaborates on both possible improvements to the existing methodology as well as a potential new baseline methodology that could be introduced in the CRM framework.

1.2 Scope and structure of the present design note

This design note aims at introducing various proposed improvements to the baseline methodology currently applied in the Belgian Capacity Remuneration Mechanism. To this end section 2 starts with a short description of the determination of Available Capacity and the role of the baseline methodology in this process. Section 3 follows with a thorough description of the existing high X of Y* baseline methodology as it is currently implemented in the CRM functioning rules. Next, Section 4 shortly describes the potential points of improvement this design note intends to address. Section 5 lists four potential improvements to the existing baseline method that Elia is currently considering to implement. Next to improving the existing baseline method, Elia is also considering the introduction of an additional baseline method in parallel. To this end, section 6 first gives an overview of potential alternative baseline methods and concludes with the selection of the most suitable alternative method. Finally, section 7 introduces a proposal for the design of a new declarative baseline that should enable the participation of a wider range of demand side management Delivery Points in the CRM.

2 Available Capacity for CMUs without a Daily Schedule

As established in the design note on the Availability Obligation[1], Obligated Capacity must be covered by Available Capacity. The latter expresses the amount of capacity that a CMU contributes at a given moment to security of supply during AMT moments.

The determination of the Available Capacity for units without a Daily Schedule is elaborated in the sections below. Non-daily Scheduled CMUs are not subject to the Outage Planning or Scheduling Process. As a result, Elia does not dispose of the same level of information allowing to calculate the Available Capacity. This section is a repetition from the Availability Obligation Design note. In order to properly assess CMU's Availability, Elia provides the framework of the Declared Prices.

2.1 Declared Prices

The Declared Prices allow Capacity Providers to submit a value representing their variable activation cost to Elia. From the moment the market price exceeds this Declared Price, Elia then knows that the CMU is expected to react to this price signal and will provide Proven Availability. When the Declared Price is not surpassed, the CMU's capacity is considered as Unproven Availability.

The surpassing of the Declared Prices leads to the establishment of the Required Volume, i.e. the amount of capacity that is expected to react to the market price signal based on the Declared Prices. Elia will monitor whether this Required Volume was actually observed in the market and will apply penalties when this is not the case.

[1] https://www.elia.be/-/media/project/elia/elia-site/electricity-market-and-system/adequacy/crm/2024/20240430_crm-design-note-prequalification-process-april2024.pdf

2.2 Three methods for the determination of the Available Capacity

Elia determines the Available Capacity for Non-daily Schedule CMUs based on the Active and Passive Volume as per section 0, and how it relates to the Required Volume based on the Declared Prices as per section 2.1.

To that extent, Elia currently distinguishes three separate methods for the determination of the Available Capacity that are applied in function of the Required Volume.

2.2.1 Method one: Required Volume is zero

When the Required Volume is equal to zero this means that none of the Declared Prices has been exceeded by the reference price, and the unit is not expected to have reacted seeing as its variable costs were not covered. In this case the Available Capacity is determined as follows:

$$P_{Available}(CMU,t) = P_{Max,Remaining}(CMU,t)$$

2.2.2 Method two: Required Volume is the NRP

When the Required Volume is equal to the NRP it means that all Declared Prices of the CMU have been exceeded, and the unit is expected to dispatch with its full capacity. The Available Capacity is in this case calculated as the minimum of the Remaining Maximum Capacity on the one hand, and the Active Volume on the other:

$$P_{Available}(CMU,t) = MIN(P_{Max,Remaining}(CMU,t); V_{Act}(CMU,t))$$

2.2.3 Method three: Required Volume is between zero and the NRP

In case the Required Volume is between zero and the Nominal Reference Power the CMU is expected to partially dispatch in response to the price signal.

The Available Capacity is then equal to the sum the capacity that reacted to the price signal, which will be counted as Proven Availability, and capacity that did not react to the price signal which will be counted as Unproven Availability. This Availability is then constrained by the notifications of Unavailable Capacity that took place. It is calculated by the following formula:

$$\begin{aligned} &P_{Available}(CMU,t) \\ &= MIN(P_{Max,Remaining}(CMU,t); MIN(V_{Act}(CMU,t); V_{req}(CMU,t)) \\ &+ MIN(V_{Pas}(CMU,t); NRP(CMU,t) - V_{req}(CMU,t))) \end{aligned}$$

2.3 Active volume for Delivery Points that deliver the service by lowering their consumption

Non-daily Schedule CMUs include units that contribute to adequacy by injection or by the reduction of offtake. Whereas injection can be assessed through Measured Power, reduction of offtake is less straightforward. Moreover, it would be cumbersome to, in the calculations of the Available Capacity, always include separate calculation methods for injection and offtake Delivery Points.

Elia as such introduces the Active Volume which allows Elia to simply use Active Volume for the remainder of the Available Capacity calculation without distinguishing between injection or offtake. The Active Volume is in first instance calculated per Delivery Point i. To obtain the total Active Volume for the CMU, the Active Volume for all Delivery Points of the CMU are summed.

The **Active Volume** is the amount of capacity that has reacted to the price signal, for offtake Delivery Points, the Active Volume is calculated as follows:

$$V_{Act,initial,i}(CMU,t) = P_{Baseline,i}(CMU,t) - P_{Measured,i}(CMU,t)$$

For both injection and offtake units, the total Active Volume is then calculated as follows:

$$V_{Act,initial}(CMU,t) = \sum_{i=1}^{n_{DP}} V_{Act,initial,i}(t)$$

This value is called initial since it can still be corrected for participation for frequency-related Ancillary Services or Redispatching Services. Following these corrections, the final Active and Passive Volume for each CMU are determined as:

$$V_{Act}(CMU,t) = V_{Act,initial}(CMU,t) + V_{Correction,AS}(CMU,t) + V_{Correction,RD}(CMU,t)$$

This Active Volume is subsequently used to determine the Available Capacity. Given that the baseline is directly used to determine the Active Volume, which in turn determines the Available Capacity, a correct and precise baseline is key to participate in the CRM.

3 Existing Baselining Methodology for the determination of Active Volume

For CMUs without a Daily Schedule that contain Delivery Points with the ability to reduce their consumption and during MTUs where the marginal cost of such a delivery point was exceeded, the Available Capacity of the CMU depends on the Active Volume. This Active Volume is in turn based on the difference between a baseline and the measured power. Therefore, an accurate determination of this baseline is paramount for an accurate calculation of the Available Capacity of CMUs containing Delivery Points with the ability to reduce their consumption, also referred to as Demand Side Management (DSM) Delivery Points.

Before diving into the methodology itself, what exactly is a baseline? In order to assess the amount of reduction that is realized during a certain MTU, Elia calculates the consumption that would have taken place in case of the absence of an activation, this consumption is called the baseline. This baseline is then compared to the measured consumption to determine the volume that was delivered.

This section intends to give a detailed overview of the existing baseline methodology used to determine the Active Volume. The baseline currently implemented in the CRM design is a High X of Y* baseline, which is a type of baseline based on historical measurements. In the High X of Y* baseline for a certain MTU, the first step is determining a set of reference days. Secondly, based on the consumption during the reference days, a baseline value is determined. Lastly, Capacity Providers also have the option to apply a baseline adjustment.

3.1 Selection of the reference days

In order to determine the baseline for a certain MTU during a day D, Elia first determines a set of Y days that are representative for day D. This set of reference days consists of the last Y days preceding day D that are of the same category as day D, with the exception of certain days that are excluded.

Elia distinguishes three different categories of days:

1. Working days
2. Weekend days and Belgian bank holidays (or holidays of the country of the Foreign Capacity)
3. Monday or first Working Day following a holiday (only after explicit request of the capacity provider)

By default, Elia will categorize the days based on the first two categories (workdays and weekend days/bank holidays). In case the capacity provider explicitly requests it to Elia, the third category of “Mondays” is also applied. In the absence of such a request, Mondays and the first Working Day following a holiday are categorized as Working days. Depending on the category of day *D* during which the baseline is going to be calculated, a different number of

Y reference days are selected to calculate the baseline:

Category of day D	Number of Y reference days
Working days	5
Weekend days / Belgian bank holidays	3
Mondays / first day following a holiday	3

Table 1: Number of Y reference days per category

As mentioned above, the Y references days are defined as the last Y days preceding day D that are of the same category as day D. However, when looking back to find these days, certain days are skipped, either by default or upon the request of the capacity provider.

The following days are not considered (and thus "skipped") by default during the determination of the reference days:

1. The day before day D
2. Days during which the delivery point was activated upon request of Elia in any of the ancillary services (aFRR, mFRR, FCR & redispatching)
3. Days during which an availability test took place
4. Days during which any of the CMU's declared prices were exceeded

In addition to the days excluded by default, the capacity provider can request to exclude additional days from the selection of the reference days, provided that this request is submitted at the latest 10 working days after the day for which the exclusion request is made. Any request should be related to one of the following reasons:

1. The Capacity Provider duly notified ELIA of Unavailable Capacity occurring on the day they wish to exclude
2. Holidays, strike days or a closing period that differ from the past and that have an impact on the injection/offtake profile of the Delivery Point

The figure below shows some examples of the selection of the set of reference days for a certain day:

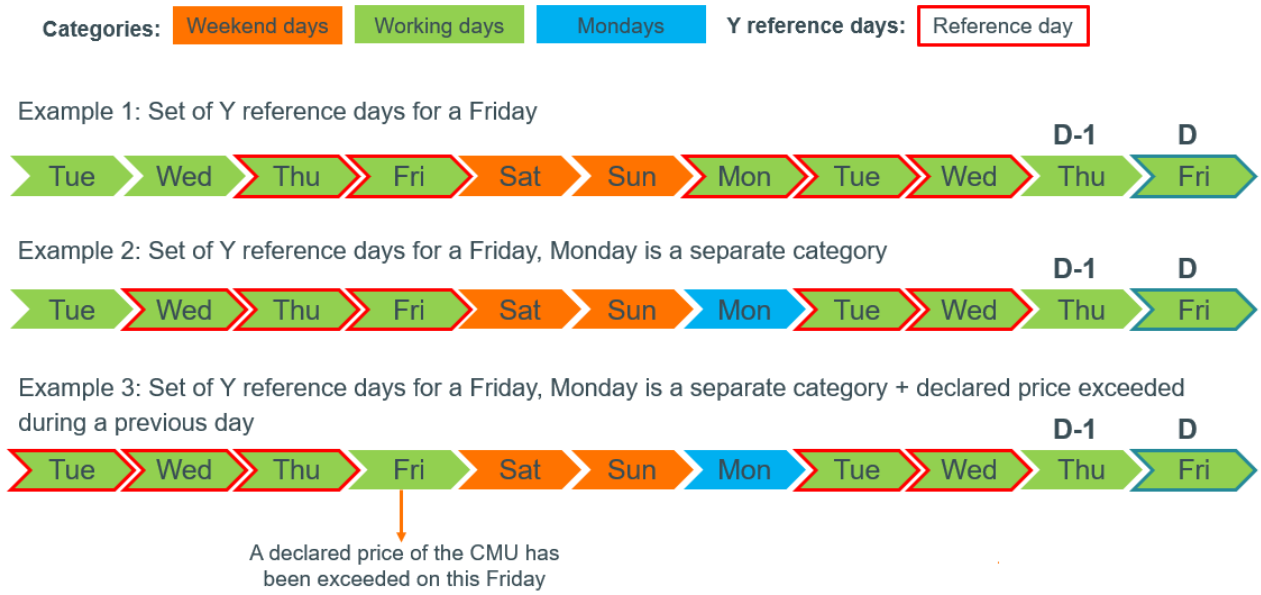

Figure 1: Selection of Y reference days

3.2 Determination of the representative days

After the set of Y references days has been selected for a day D, and before the baseline for the MTUs on day D can be calculated, Elia will first select X representative days from the Y reference days. Only the metering data on these days will be used to calculate the baseline. Depending on the category of day D, the number of X representative days will be different, as summarized in the table below:

Category of day D	**Number of X days selected from Y reference days**
Working days	4
Weekend days / Belgian bank holidays	2
Mondays / first day following a holiday	2

Table 2: Number of X representative days per category of reference days

The X representative days correspond to the days (out of the Y reference days, determined as described above) for which the average net offtake of active power during the period corresponding to the period covered by the AMT Moment on day D is the highest. An example is given below:

Baseline calculated on Friday 14/03/20XX (category: workday) AMT moment on 14/03: 16:30 – 17:15 (3 consecutive MTUs)		
Y Reference days	Average net offtake during 16:30 – 17:15 on each reference day [MW]	Selected in X days?
Wednesday 12/04	12,53	Yes
Tuesday 11/04	11,23	No (lowest value)
Monday 10/04	14,80	Yes
Friday 07/04	14,21	Yes
Thursday 06/04	13,95	Yes

Table 3: Determination of X representative days: example

3.3 Calculation of the baseline

Lastly, once the X representative days are known, the baseline for any MTU during day D is calculated as the average of the net offtake during the identical MTUs on the X days. For example, to calculate the baseline for the MTU from 16:30-16:45, the average is taken of the net offtake values between 16:30 and 16:45 on the X days. Again, an example of this calculation is shown below:

Baseline calculation on Friday 14/03/20XX (category: workday) Baseline calculated for 14/03: 16:30 – 16:45		
Y Reference days	Average net offtake during 16:30 – 16:45 on each reference day [MW]	Selected in X days?
Wednesday 12/04	12,98	Yes
Tuesday 11/04	-	No (lowest value)
Monday 10/04	14,05	Yes
Friday 07/04	13,75	Yes
Thursday 06/04	14,44	Yes
Average of consumption during equivalent MTUs on the X days = $P_{baseline}$	13,81	-

Table 4: calculation of the baseline: example

3.4 Requesting a baseline adjustment (same-day adjustment)

Capacity providers have the possibility to request a baseline adjustment, also known as a same-day adjustment (SDA). The SDA enables to consider to some degree the injection/offtake that is dependent on external conditions on the day of the activation. This is specifically interesting for capacity providers with industrial sites where multiple electricity intensive assets are present and where only some of these assets are used to deliver the flexibility. In this case the consumption level of the non-flexible assets can have an impact on the consumption data and therefore on the baseline of the flexible assets. A same-day adjustment can limit this impact.

In order for such a request to be granted, the request must fulfill the following conditions:

1. The request is submitted for a specific Delivery Point and MTU
2. The request is justified by the capacity provider
3. The baseline with adjustment is more accurate than the baseline without adjustment over a period of 90 days preceding the day of the MTU for which the request was submitted

The third condition above is verified by comparing the Root Mean Square Error (RMSE) of the baseline during the 90 days prior to the requested adjustment. If the RMSE calculated using the baseline with adjustment is lower than the RMSE calculated using the baseline without adjustment, for more than 75% of the days considered, the condition is satisfied. If the request is granted, the baseline with adjustment is used for the Delivery Point and MTU included in the request.

The RMSE for a day D is calculated as follows:

$$RMSE(D) = \sqrt{\frac{1}{N}\sum_{t \in D}(P_{Baseline}(t) - P_{Measured}(t))^2}$$

The value above is calculated for both the baseline with and without adjustment and compared for each day during the 90 days prior to the requested MTU to be adjusted. The following days during this 90-day period are not considered:

1. Days during which a (partial) declared price of the CMU was exceeded
2. Days during which the delivery point was activated in one of the ancillary services (aFRR, mFRR, FCR or Redispatching)

3.5 Calculating the baseline with same-day adjustment

In order to calculate the baseline with adjustment, a certain correction value is added to the baseline for each MTU *t*. The adjustment factor is defined as the difference between the average net offtake during the adjustment period for the requested MTU on day *D* and the average net offtake during the same adjustment period for the equivalent MTUs during the *X* days used to calculate the baseline. This is mathematically expressed as follows:

$$P_{Baseline,Adjusted} = P_{Baseline}(t) + P_{Adjust}(t)$$

$$P_{Adjust}(t) = P_{Adjust,D}(t) - P_{Adjust,X}(t)$$

$$P_{Adjust,D}(t) = \frac{1}{3}\sum_{t=T-6}^{T-3} P_{measured}(D,t))$$

$$P_{Adjust,X}(t) = \frac{1}{3 \cdot N_x}\sum_{d \in X}(\sum_{t=T-6}^{T-3} P_{measured}(d,t))$$

Where *T* is the start of the AMT Moment, the adjustment period is therefore a three-hour period that starts six hours before the start of the first MTU *t* of the AMT Moment and ends three hours before the start of the AMT moment at MTU *t*. The figure below demonstrates this graphically:

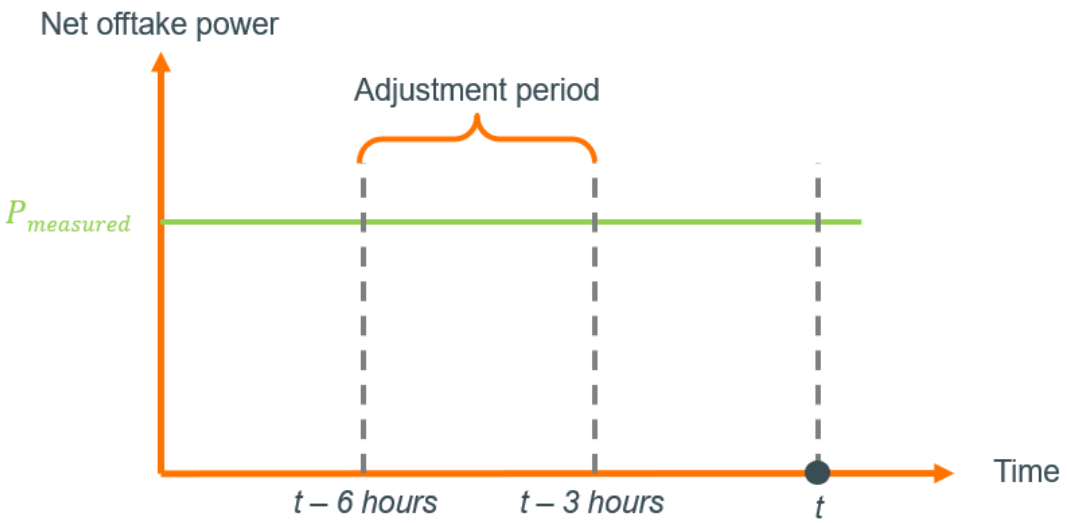

Figure 2: Adjustment period for the baseline correction value for a certain AMT Moment starting at MTU t

4 Possible improvements to the existing baseline design

The existing baseline methodology as presented in section 3, is a proven baseline method that is used in a variety of other services and products, including in the Transfer of Energy framework[2] and mFRR. Despite its proven trackrecord, there is still room to improve the baseline methodology in the CRM.

The baseline methodology applied in the CRM can be made more inclusive:

The currently used high X of Y* baseline methodology can only accurately estimate the baseline for a specific type of delivery points that have a cyclical weekly or daily consumption pattern. The baseline could therefore be made more inclusive for delivery points which do not have such a cyclical offtake pattern.

The current baseline methodology relies on a daily or weekly cyclical offtake pattern of the DSM Delivery Point in order to accurately estimate the baseline. An accurate baseline is essential to enable the participation of Demand Side Management in the CRM, as the baseline has a direct impact on the calculation of the Available Capacity. An imprecise baseline currently prevents a large group of potential Capacity Providers from participating in the CRM. The baseline methodology could be improved to also allow capacities that do not have a cyclical offtake pattern to participate to the CRM.

The baseline methodology can be simplified:

The current methodology allows for different types of reference days, various different days to be excluded and multiple options to contest or apply for exceptions like excluding several days from the calculation or the application of a baseline adjustment. This results in a complex methodology that could be further simplified towards a single standard baseline calculation (with no or less optional elements) that is more straightforward to interpret.

In addition to being mainly designed for a group of DSM Delivery Points with a cyclical offtake pattern, the existing design is also complex. In order for Capacity Providers to better evaluate whether or not the baseline methodology applied is suitable for their specific process, the design could be simplified. This increased transparency and clarity should decrease the barriers to entry.

To improve the baseline methodology, Elia proposes two different evolutions in the remainder

[2] Transfer of Energy rules (NL)

of this design note:

- Several potential improvements of the existing baseline methodology, aimed at simplification and improved accuracy.
- The introduction of an additional baseline methodology

5 Improvements to the existing baseline methodology

To improve to accuracy for a wider range of potential users and simplicity of the current baseline design, this section aims to introduce four specific modifications to the design that could be introduced to realize these goals:

1. The baseline adjustment is applied by default
2. The baseline adjustment design is made asymmetric
3. The “Monday” category for reference days is removed
4. Selection of X representative days per individual MTU

These changes are not aimed at creating a new baseline methodology, but are rather aimed at removing certain administrative aspects of the design that lead to a simplification of the process while at the same time result in an improved accuracy. Next, some of these changes were already part of the recommendations in an earlier baseline assesment study performed by Elia, in which baseline methodologies for a wide range of products were compared and evaluated[3]. Note that Elia aims to keep the baseline methodologies aligned between CRM, mFRR and ToE but that this alignment is currently only considered at a later stage.

5.1 Apply the baseline adjustment by default

Historical baseline methodologies without same-day adjustment can have difficulties in achieving a high accuracy for assets with an offtake/injection pattern that do not follow a systematic daily/weekly pattern. For instance, this can be the case for renewable generation, weather dependent loads, different loads behind the same meter or loads/generation with a general volatile profile (e.g. residential load).

However, historical baseline methodologies with a same-day adjustment can ensure a higher accuracy for a wider range of assets as the adjustment enables to consider to some degree the injection/offtake that is dependent on external conditions on the day of the activation. This is graphically illustrated in the figure below. The figure shows a process with a constant offtake during the reference days, which will determine its baseline.

- However, on the day itself an extra process is also consuming energy, increasing the consumption relative to the reference days.

[3] baseline study performed by Elia

- Even though the unit drops its consumption at the moment of activation, no difference with the baseline is observed. The graphs on the second row, show the impact of applying the SDA, which will increase the baseline by the amount of the extra process in this simplified case.
- As a result, a difference between the baseline and the consumption can be found and the activation is correctly taken into account. By using the SDA the effect of certain processes on the relative height of the consumption can partially or completely be eliminated.

Therefore, applying a same-day adjustment can both make the current baseline methodology more inclusive and more accurate.

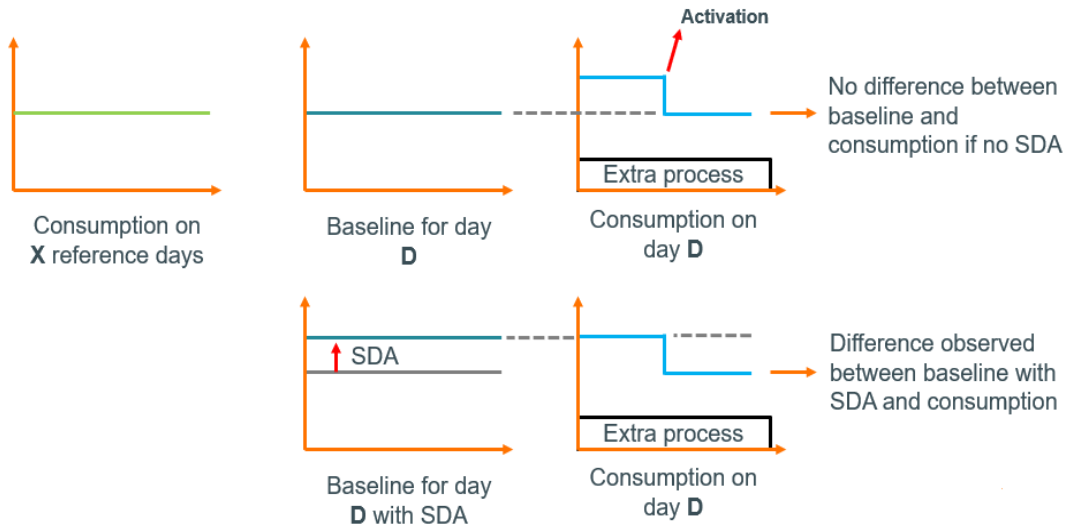

Figure 3: same-day adjustment example

In the current baseline design of the CRM, applying the same-day adjustment (SDA) is only triggered at the explicit request of the Capacity Provider and for a single MTU at a time. As explained in section 3 above, the determination of wheter or not an SDA is allowed is complex and therefore poses a significant barrier to apply the more accurate version of the Baseline. At the same time, this barrier is only reinforced by the fact that the SDA must be requested for each MTU and Delivery Point individually. Instead it could make sense to apply the SDA by default, as this improves the accuracy of the Baseline, simplifies the current process and ensures the baseline is more accurate and therefore inclusive for a variety of DSM Delivery Points.

Improvement I:

It is proposed to apply the baseline adjustment by default, meaning that only the High X of Y baseline with adjustment would be used. This results in a significant simplification and at the same time in a more accurate calculation of the baseline.

5.2 Make the baseline adjustment asymmetric

The existing same-day adjustment in the CRM design is applied symmetrically. This means that the SDA can lead to both a positive and a negative baseline adjustment. Naturally, Capacity Providers will not request an adjustment for an MTU if a negative baseline adjustment will be applied. In case the SDA is applied by default, it would also be applied at times when Capacity Providers would not have requested this adjustment. To ensure that the automatic application of the SDA is only applied at times when Capacity Providers would have requested it anyway, the SDA is made asymmetric. The result of applying this second design modification, in combination with the one discussed above is that the updated design is able to realize the same outcome as the current design, but at the same time eliminates the administration, calculations and complexity for the Capacity Provider. The proposed modification to the calculation of the same-day adjustment is summarized below:

Current design:

$$P_{Baseline,Adjusted}(t) = P_{Baseline}(t) + P_{Adjust}(t)$$

$$P_{Adjust}(t) = P_{Adjust,D}(t) - P_{Adjust,X}(t)$$

Proposed modification:

$$P_{Baseline,Adjusted}(t) = P_{Baseline}(t) + P_{Adjust}(t)$$

$$P_{Adjust}(t) = Max\{0;\ P_{Adjust,D}(t) - P_{Adjust,X}(t)\}$$

Improvement II:

It is proposed to apply an asymmetric same-day adjustment to ensure it is only applied when Capacity Providers would have requested it. This results in the elimination of administration, calculations, and complexity for Capacity Providers and enables the default application of the SDA.

5.3 Remove the "Monday" category for reference days

The accuracy of historical baseline methodologies is dependent on the selection of data closer to the day of activation. The underlying assumption is that data closer to the day of activation is more relevant for the consumption during the day itself. In the High X of Y* baseline methodology, the selection of data is based on the selection of X reference days. As detailed in section 3 above, a number of days are excluded to be used as potential reference days for the baseline on a day D, including:

1. The day before day D
2. Days during which the delivery point was activated upon request of Elia in any of the ancillary services (aFRR, mFRR, FCR & redispatching)

3. Days during which an availability test took place
4. Days during which any of the CMU's declared prices were exceeded (signaling activation in either day-ahead, intra-day or for imbalance)

In addition, Capacity Providers have the possibility to request the removal of additional days, provided they provide a sound justification. The above demonstrates that a large number of days are potentially excluded from the set of potential reference days. As a result, the calculation of the baseline can result in the use of data further away from the day of activation, which in turn negatively impacts the accuracy of the baseline methodology. At the same time, Capacity Providers have the option to request an additional category of reference days: "Mondays & days following a Belgian bank holiday". The result of applying this additional type of reference day is that for the other categories of reference days the number of possible days is reduced, which leads to selecting reference days further away from the day of activation. At the same time, the "Monday" category will use days multiple weeks away from the day of the activation, potentially resulting in using less relevant data. Next, the baseline used to calculate the Capacity Provider's NRP does not use this type of reference day. To bring the baseline method used in the Availability Obligation more in line with the NRP calculation methodology, as well as improve the accuracy, it is proposed to no longer use this category of reference days. This can potentially impact a very specific group of processes, however, the improvements to either the baseline adjustment or the introduction of the alternative baseline option as discussed in the remainder of this design note, compensate for this.

Improvement III:

It is proposed to remove the "Monday and days following a holiday" category option for the determination of the reference days. This brings the baseline design more in line with the NRP determination, improves the accuracy of the baseline and further simplifies the baseline methodology.

5.4 Selection of X representative days per individual MTU

As explained in section 3 above, to calculate the baseline on a certain day D, the first step is to select a number of Y reference days. Next, only X representative days are selected from the Y reference days. In the current design, the X days are selected based on the average consumption on the X days during the period covered by the AMT moment that occurred on day D. Only the X days with the highest average consumption during this period are retained. However, the step of selecting the X reference days based on the average consumption during the AMT Moment could be omitted. Instead, the baseline for a certain MTU t would be calculated by taking the X highest values of consumption on the identical MTUs on the Y reference days. As a result, the selection of the X representative days could be different for each individual MTU t of the AMT Moment.

Adapting the selection of the X representative days like this simplifies the calculation of the baseline and therefore makes it more transparent to capacity providers. In addition, it brings the design of the baseline further in line with the baseline as applied in the determination of the NRP during the Prequalification Process.

Improvement IV:

It is proposed to remove the step of selecting the X reference days based on the average consumption during the period equal to the AMT moment on day D. Instead, the baseline is directly calculated as the average of the X highest values out of the Y identical MTUs on the Y reference days.

6 Introduction of an additional baseline methodology in the CRM

To enable the participation of DSM Delivery Points that do not have a cyclical offtake pattern to the CRM, an additional baseline methodology can be introduced in parallel with the existing one implemented today, therefore further enabling participation of DSM in the CRM. This section first provides an overview of the criteria to which a baseline method should adhere in the CRM. Secondly, different known baseline methodologies are compared to these criteria to determine the best candidate. The analysis in this section is based on an earlier study[4] on baseline methodologies performed by Elia in which Elia already made several recommendations to improve the baseline methodologies of the CRM among other products.

6.1 Baseline design criteria

Baselines can be evaluated based on a large number of criteria, however for the introduction of an additional baseline methodology in the CRM, four key criteria are identified:

1. **Inclusivity**: any new baseline method should be inclusive for DSM delivery points for which the current High X of Y* method is not suited.
2. **Integrity**: the context of the CRM, in which activations are expected to be rare and are know one day in advance, requires special attention to baseline integrity.
3. **Simplicity**: any additional baseline should be as simple as possible
4. **Accuracy**: the baseline accuracy for DSM delivery points without a weekly/daily pattern should be better than the existing methodology for the new baseline to be of any added value. Additionally, an accurate baseline can also help to ensure integrity.

[4] Baseline study

6.2 Alternative baseline methodologies

There exist many alternative baseline methodologies that could be applied in a CRM context, the table below gives an overview of the most prevalent baseline methodology groups and a short description:

Methodology group	Short description
Meter Before – Meter After (MBMA)	MBMA baseline methodologies calculate the baseline by taking a single meter reading before the period of activation or by taking the average/median/maximum/minimum value of several meter readings before the period of activation. As such, MBMA baseline methodologies result In baselines that are constant during the entire period of activation.
Historical baseline methodologies	Historical baseline methodologies make use of historical offtake/injection measurement data (usually recent data of several days prior to the day of the activation) to calculate the baseline for the period of activation. The High X of Y* baseline method falls under this category.
Declarative baselines	Declarative baseline methodologies rely on the estimation, as provided by the capacity provider to the TSO, of the offtake or injection pattern of the asset or portfolio if no flexibility activation would take place. This forecast is sent before gate closure or at another predefined deadline. In general, the calculation of the baseline is left to the discretion of the capacity provider.
Regression-based baseline methodology	Regression-based baseline methodologies use a regression model and historical data to estimate the offtake/injection during the period of activation. Regression-based baseline methodologies can use, among others, schedule, weather and other variables to forecast offtake/injection profiles during the period of activation.
Calculated baseline methodology	Calculated baseline methodologies involve a calculation of the baseline based on external parameters, such as weather conditions, typically without relying directly on historical data of measured offtake/injection. Calculated baseline methodologies are not commonly applied as they are applicable only to technologies and assets for which the offtake/injection profile can be calculated based on external parameters.
Control group baseline methodology	Control group baseline methodologies determine the baseline by taking the average/median of measurements of the offtake/injection of similar customers/assets that do not participate in the flexibility service.

Table 5: baseline methodology overview

Based on the table above, several baseline methodology groups are excluded as a potential candidate for the CRM:

- The **control group baseline methodology** can be excluded based on the high level of heterogeneity of the DSM delivery points participating to the CRM, as such there is no relevant control group to which delivery points in the CRM can be compared to. Therefore, not fulfilling the accuracy and simplicity criteria.
- The **calculated baseline methodology** assumes that the baseline of a DSM delivery point can be calculated based on external parameters, without considering historical consumption. As mentioned earlier, given the high level of heterogeneity this would require developing a separate method for each individual DSM delivery point, assuming its consumption can even be estimated based on external parameters. This method is deemed infeasible due to its complexity and its potential lack of inclusivity.
- The **regression-based baseline methodology** requires building a regression model to estimate a delivery point's future consumption based on both historical consumption and other external parameters. It improves on the High X of Y* methodology by allowing for a more complex consideration of past consumption to estimate the baseline. However, similar to the calculated baseline methodology this method is also deemed too complex to be feasible. In addition, it is only applicable to DSM delivery points for which future consumption can be accurately estimated based on historical data and/or external parameters, not fulfilling the inclusivity requirement.
- The **Meter Before – Meter After methodology** (MBMA) only takes into account consumption right before the activation to estimate the baseline. However, in the context of the CRM, "activations", or rather moments of availability obligation, are known already in day-ahead. Therefore, this baseline methodology does not fulfill the integrity criterium, as DSM delivery points can anticipate the availability obligation and temporarily increase their consumption to ensure a desired baseline level.
- Similar to regression-based baseline methodologies, **historical baseline methodologies** estimate future consumption based on past consumption, but do not consider any external factors. The downside of historical baseline methodologies is twofold. First, they are not inclusive for consumption profiles for which past consumption is not a good indication of future consumption. Secondly, a single type of historical baseline calculation, is typically only useful for a relatively small group of specific consumption profiles. Therefore, it would require either adding multiple different baseline calculation formulas based on historical data to ensure inclusivity at the expense of complexity or, only add one additional calculation but risk being not inclusive. Based on the above, it appears adding a second baseline methodology based on historical data does not allow to fully integrate consumption profiles without a systematic weekly or daily consumption profile and is therefore not further considered as a potential candidate.

Elia currently considers the "declarative baseline" methodology group as the only realistic candidate for the introduction of an additional baseline in the CRM design as it can fulfill all the baseline design criteria set out above:

1. **Inclusivity**: Declarative baseline methodologies are considered the most inclusive as it enables capacity providers to provide a forecast of the offtake pattern based on any calculation methodology and considering all relevant and available data.
2. **Simplicity**: From a design perspective, a declarative baseline only requires describing the modalities of the baseline submission and baseline quality constraints and does not require introducing complex calculations and processes. This limits the added complexity of an additional baseline in the CRM.
3. **Accuracy**: The baseline accuracy that can be achieved fully depends on the ability of the capacity provider to estimate future consumption. To ensure sufficient precision can be guaranteed, the quality of the baseline will need to be verified.
4. **Integrity**: Given that it is the capacity provider itself who calculates the baseline and submits it to Elia, special attention should be given to baseline integrity.

In addition to the points raised above, several capacity providers specifically proposed the addition of this baseline methodology during the public consultation of the last version of the CRM functioning rules (v4)[5]. Elia would also like to note that the concept of a declarative baseline is already being used in other products. Elia already applies a declarative baseline for the provision of aFRR (in which the baseline is submitted 60 seconds in advance). In addition, RTE also provides the option of a declarative baseline for the block exchange notification mechanism of demand response, known as “NEBEF”[6]. In this mechanism the baseline is submitted one week in advance for the entirety of the following week. A declarative baseline is therefore not a new concept, but still requires specific attention to the context in which it is going to be applied.

[5] Public consultation report functioning rules v4.
[6] Block exchange notification mechanism of demand response (relevant section: 7.2.4)

7 Proposed declarative baseline design

As explained in section 4, Elia is considering the introduction of a new declarative baseline in parallel with the existing High X of Y* baseline methodology that is applied in the availability monitoring process. This section aims to introduce a design proposal for this declarative baseline. First the general principle of a declarative baseline is introduced. Next, the operational modalities and the impact of the introduction of the new methodology on the different processes within the CRM are further explained.

7.1 Principle

A declarative baseline relies on the forecast, as provided by the capacity provider, of the consumption of the delivery point in case no activation of the delivery point would take place. This forecast is sent before a pre-determined deadline to the TSO. The calculation of the baseline is left at the discretion of the capacity provider. The advantage of this approach is that each capacity provider can use a baseline calculation methodology that is best suited to his assets and that can consider the specificities and external factors that are relevant to him. As such, this methodology allows to accommodate a wide variety of consumption profiles.

7.2 Declarative baseline design: prequalification process

When participating to the CRM, the prequalification process is the first process capacity providers come into contact with. The process is designed to verify the volume a capacity provider can offer into the auction, as well as any other requirements required to submit a bid into the auction. During the prequalification phase, a historical baseline method is applied to determine the nominal reference power of each delivery point. The introduction of the declarative baseline, however, does not impact the determination of this nominal reference power. The declarative baseline cannot be used during the prequalification phase for the calculation of the nominal reference power of the delivery point. Additionally, capacity providers will also not be requested to inform Elia about their desire to apply the declarative baseline for the delivery process during the delivery period. This ensures that the introduction of the declarative baseline has no impact on the prequalification process and prevents the addition of any additional administration at this point. In addition, capacity providers do not yet need to know well in advance if and how they would use the declarative baseline.

Declarative baseline design proposal I:

The introduction of the declarative baseline has no impact on the prequalification process:

1) The nominal reference power of demand side management delivery points will be calculated based on the existing methodology.

2) No information related to a potential usage of the declarative baseline will need to be

provided during the prequalification stage, preventing any additional administrative burden.

7.3 Declarative baseline design: availability monitoring

During the availability monitoring Elia will use the baseline as declared by the capacity provider in the determination of the active volume. The remainder of this section describes the practical modalities regarding the baseline notification, submission, quality validation as well as the fallback procedure for certain cases.

7.3.1 Notifying use of the declarative baseline

Capacity providers will be required to notify Elia of their desire to apply the declarative baseline for a specific delivery point. Such a notification must be sent to Elia at least 15 working days before the capacity provider can start submitting the declarative baseline. Whenever such a request is made during a delivery period, the capacity provider is expected to submit a declarative baseline for the remainder of the delivery period. Note that Elia will only be able to use the declarative baseline for a certain month M, in case the baseline was submitted for all days of month M.

By only requiring this notification relatively close to delivery, capacity providers are not yet required to commit to using the declared baseline before an auction four, two or one years in advance. Additionally, they also do not yet need to know exactly how they plan to calculate their declared baseline well in advance. Allowing them to only deliver their calculation method close to delivery should ensure that they have a good view on their assets and how they will be used to fulfill the CRM contract.

Declarative baseline design proposal II:

Capacity providers need to inform Elia about the usage of the declarative baseline:

1) Capacity providers notify to Elia which delivery points will use the declarative baseline 15 working days before the first submission can take place

2) Capacity providers are expected to submit a declarative baseline for the remainder of the delivery period after their notification to Elia.

7.3.2 Baseline submission

With regards to the submission of the baseline, both the baseline quality and integrity are of importance. On the one hand, by requiring that the baseline for a certain day is submitted well in advance, potential manipulation can be avoided since it is harder to predict whether or not a certain quarter hour will be an AMT MTU in the CRM. On the other hand, submitting the baseline well in advance comes at the potential cost of baseline quality, as making a prediction further into the future, naturally renders it more inaccurate. Therefore, to balance both quality and integrity, capacity providers will be requested to submit the declared baseline

for a certain day D before D-1 11:00. This ensures the baseline is submitted before the publication of the day-ahead market clearing results, and therefore before capacity providers know which MTUs could be subject to the availability monitoring process.

Next, the declared baseline is submitted per delivery point and includes a positive value in MW for each market time unit of the day-ahead market. In case Elia either receives no declared baseline for a delivery point, or the declared baseline contains missing values for certain MTUs, Elia will automatically consider the declared baseline to be 0 MW in both cases. Setting the declared baseline to 0 MW is intended as incentive to ensure the correct and timely delivery of the declared baseline.

Declarative baseline design proposal III:

Capacity providers submit a declarative baseline to Elia.

1) The baseline is submitted per delivery point

2) The declared baseline is a positive MW value for each MTU on the day-ahead market.

3) The declared baseline for a day D is submitted before D-1 11:00

4) In case of any missing values Elia will apply a declared baseline of 0 MW

7.3.3 Validating baseline quality

As already mentioned in previous sections, integrity of the declared baseline requires special attention. To ensure the declared baseline's integrity, Elia intends to verify its quality. To do so, Elia proposes to use the "Quality Factor" as defined in the framework of aFRR[7], but slightly adapted to fit the CRM context. Elia already uses this metric to determine the quality of declarative baselines submitted for the delivery of aFRR. The Quality Factor is used to ensure that the declarative baseline is in line with the actual consumption of the Delivery Point in the absence of an activation of the Delivery Point. **If the baseline quality is sufficiently high for sufficient amount of time outside of activations, Elia believes it is reasonable to assume that the submitted baseline is also of high quality for MTUs during which an activation took place.** In this way the Quality Factor is able to ensure baseline integrity. The proposed quality level is adapted to the context of the CRM: given that the baseline needs to be submitted significantly in advance compared to aFRR, it is expected that the quality of the prediction will be lower and therefore the required quality level also needs to be lowered to takes this into account. The Quality Factor is calculated on a monthly basis and must be equal to or exceed 80% for each month M:

[7] T&C BSP aFRR

$$\textbf{Quality Factor}(\boldsymbol{DP},\ \boldsymbol{M}) \geq \mathbf{80\%}$$

The quality factor for a month M is calculated as the average quality of each day D throughout the month:

$$\text{Quality Factor}(DP,\ M) = \frac{\sum_{D \in M} Quality\ Factor(DP,\ D)}{N}$$

In turn, the Quality Factor for a certain day D is defined as follows:

$$\text{Quality Factor}(DP,\ D) = 1 - \frac{RMSE(DP, D)}{Max\ (\frac{1}{N}\sum_{t \in D} P_{Baseline}(DP, t);\ 1)}$$

Where:

- $RMSE(DP, D)$ is the root mean square error for delivery point DP on day D, defined as:

$$RMSE(DP, D) = \sqrt{\frac{1}{N}\sum_{t \in D} [P_{Baseline}(DP,\ t) - P_{measured}(DP,\ t)]^2}$$

As the declared baseline is **only expected to be equal to consumption in the absence of an activation**, Elia proposes to exclude the following MTUs from the calculation of the Quality Factor:

- All MTUs t during which at least one of the declared prices of the CMU (of which the delivery point is part of) is exceeded. Declared prices can be submitted for day-ahead, intra-day and imbalance market segments.
- All MTUs t during which the Delivery Point was activated by Elia in any of the balancing services (aFRR, mFRR, FCR, Redispatching)
- The first two MTUs following any of the MTUs from the first two bullet points above.

Excluding MTUs should allow for value stacking: it allows the delivery point to be active in other segments in the energy market without negatively impacting its baseline quality evaluation in the CRM. To ensure a sufficiently accurate calculation of the Quality Factor, Elia will however require that at least 60% of the MTUs that occur during a certain month M remain for the calculation, meaning Elia will only calculate a Quality Factor when less than 40% of the MTUs occurring during a certain month are excluded. In practice this means that the Delivery Point can activate up to ~300 hours per month.

Declarative baseline design proposal IV :

Elia will verify the quality of the declarative baseline each month.

1) Baseline quality is evaluated using the “Quality Factor”, as defined in the T&C BSP aFRR.

2) The minimum quality level for a month M is set at $QF(DP, M) \geq 80\%$.

2) For the calculation of the Quality Factor, MTUs during which the Delivery Point was activated are excluded, as well as the first two MTUs following an activation.

3) Elia requires that at most 40% of the MTUs of a certain month M are excluded in order to calculate the Quality Factor with sufficient accuracy.

7.3.4 Fall-back procedures in case of insufficient baseline quality

The quality factor ensures that the declarative baseline is in line with the actual consumption of the Delivery Point in the absence of an activation of the Delivery Point. If the baseline quality is sufficiently high for sufficient amount of time, Elia believes it is reasonable to assume that the submitted baseline is also of high quality during MTUs during which an activation took place. In this way the Quality Factor is able to ensure baseline integrity. As mentioned earlier, the baseline Quality Factor is calculated for each month M individually. In case it appears that for a certain month M the Quality Factor is not sufficiently high enough or in case not enough MTUs were available to reliably estimate the Quality Factor, baseline integrity is not safeguarded and therefore the declarative baseline cannot be used. In this case a fall-back procedure should apply. In case this situation occurs during a certain month M, Elia proposes to apply the already existing High X of Y* baseline methodology instead of the declarative baseline **for that specific month M only**. The Capacity Provider can still continue, and is still expected to submit a declarative baseline for the remaining months of the Delivery Period. In case the baseline quality is again sufficient in a later month, the submitted declarative baseline will again be used. Note that when no declarative baseline is submitted, Elia assumes 0MW for the missing values. In case this happens often enough, the baseline quality will automatically be low for a specific month M, and automatically the existing high X of Y* baseline methodology will apply instead.

Declarative baseline design proposal V:

Elia does not use the submitted declarative baseline for a specific month M in case at least one of the following two conditions are fulfilled:

1) The Quality Factor for month M is lower than 80%

2) More than 40% of all MTUs occurring during month M were excluded from the Quality Factor calculation

Whenever this occurs, Elia will instead use the existing high X of Y* baseline methodology for that specific month M.

7.4 Additional design elements to better take into account participation in other segments of the energy market

The target design of the declarative baseline as detailed above contains the essential elements that Elia believes are necessary to implement the new baseline methodology. However, several additional elements could potentially be included to the design in order to further increase the accuracy of the method but at the cost of additional complexity. Two additional elements are also under consideration by Elia at this point:

1) Allowing the declarative baseline to be updated closer to real time
2) Taking into account activated volumes in the calculation of the Quality Factor

Capacity providers are also welcomed to suggest other potential design improvements to the target design as presented above.

7.4.1 Updating the declarative baseline

The design proposal as outlined above, only takes into account a single declarative baseline submission at D-1 11:00. Forecasting this far before real time naturally renders it less accurate, which can have a negative impact on the quality of the baseline and therefore on the ability of the capacity provider to utilize the declarative baseline. Instead of only applying a single submission gate, additional updates throughout the intra-day timeframe could be envisaged to allow a baseline nomination closer to real time. This could better enable participation to energy markets in the intraday timeframe. In case such updates would be allowed, several additional constraints would need to be added in order to guarantee baseline integrity. In order to prevent that a baseline value could be set strategically, the baseline update will not be used for the following MTUs:

- All MTUs for which the AMT price is exceeded (indicating it would an AMT MTU)
- All MTUs for which at least one of the declared prices of the CMU was exceeded
- All MTUs for which the unit was activated in one of the ancillary services (aFRR, mFRR, FCR, Redispatching)

In terms of timing, baseline updates would be allowed in line with the intraday auctions, meaning that up to three updates would be allowed. The deadline for each update would be set at the gate closure time for each intraday auction, e.g., D-1 15:00, D-1 22:00 & D 10:00. The capacity provider would then again submit a baseline value for all MTUs on day D. In case of the third baseline update, in line with the last intraday auction for day D, the baseline would only be submitted for the second half of day D (12:00-24:00).

Declarative baseline design proposal VI (optional):

Elia can allow updates of the declarative baseline after the initial submission at D-1 11:00

- Up to three updates would be allowed
- The update deadlines would be in line with the GCT of the intraday auctions at D-1 15:00, D-1 22:00 & D 10:00

- The update will not be used for all MTUs during which the AMT price was exceeded, at least one declared price of the CMU was exceeded, or for MTUs during which the CMU was activated in any of the ancillary services

7.4.2 Including activated volumes from ancillary services in the Quality Factor calculations

As mentioned above, in order to guarantee an accurate calculation of the Quality Factor, Elia requires at most 40% of all MTUs occuring during a month M are excluded from the calculation. In other words capacity providers can only activate their unit up to 40% of the time in a certain month. For some capacity providers who activate frequently, this could be a constraint preventing them from nominating a baseline.

Alternatively, Elia could not exclude MTUs during which an activation took place for the provision for ancillary services, but instead correct their consumption with the volume that was activated by Elia. Meaning that MTUs during which the delivery point was activated in either aFRR, mFRR or Redispatching would not be excluded anymore from the calculation of the Quality Factor. This potentially enables the capacity provider to activate up to 40% of all MTUs only in either DA, ID or for imbalance. In case the delivery point was activated in both ancillary services and DA/ID/Imbalance, the MTU would still be excluded.

Declarative baseline design proposal VII (optional):

Elia does not exclude MTUs during which the CMU was activated in either aFRR, mFRR or Redispatching for the calculation of the quality factor.

Instead, during those MTUs Elia will correct the measured consumption with the activated volume of the ancillary service delivered.

8 Declarative baseline example

This section presents a numerical example of the design proposal as outlined above. To this end, consider a capacity provider with an industrial production site as shown in Figure 4: declarative baseline example: site layout below. The site contains the following elements:

- An asset whose consumption is flexible
- An asset whose consumption is not flexible
- A PV installation

This capacity provider wishes to offer his flexible asset in the CRM as a demand side management delivery point and use the declarative baseline to determine its active volume during the availability monitoring.

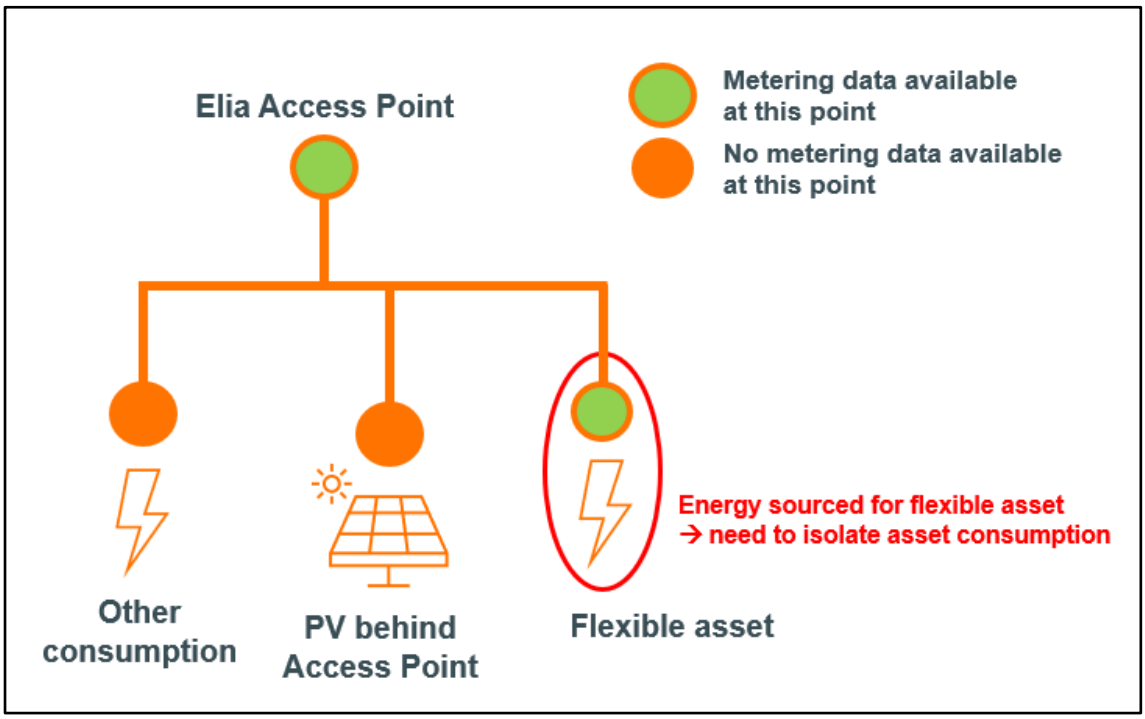

Figure 4: declarative baseline example: site layout

8.1 Prequalification: attention points for demand side management

In order to participate to the CRM, the capacity provider must first prequalify. To prequalify the flexible asset, he has two options:

1) Prequalify the Elia access point
2) Prequalify the delivery point related to the flexible part of the consumption that is situated behind the access point

Elia will **calculate the nominal reference power of the DSM delivery point based on the**

net offtake power: offtake - injection. In case the access point would be prequalified, this means that the production of the PV installation would be subtracted from the demand before the baseline method would be applied. Because of this, the baseline method would not deliver an accurate result, both during the prequalification and the availability monitoring stage.

Therefore, in order to accurately determine a baseline, it is crucial that a meter is installed such that the consumption (asset) is metered separately from injection and that the DSM delivery point behind the access point can be prequalified. **In general, prequalifying a metering point behind which both consumption and production assets are present should be avoided in case the capacity provider aims to offer the demand flexibility** (and not the production asset). If this is not the case, the baseline calculations will deliver inaccurate results, rendering Elia unable to accurately measure the contribution of the demand side flexibility.

8.2 Availability monitoring

During the delivery period itself, the capacity provider is required to provide various information to Elia, including (at least) declared prices for the day-ahead market. The table below shows the declared prices for the CMU in this example:

Declared price day-ahead	
Volume [MW]	**Declared Price [Eur/MWh]**
25	100
75	200
100	220

Table 6: declarative baseline example: declared prices

The table indicates that the capacity provider will react with 25MW in case the day-ahead price exceeds 100Eur/MWh, e.g., consumption of the flexible asset will be 25MW lower whenever this happens.

In addition the capacity provider also chooses to declare a baseline instead of using the high X of Y* baseline method. Figure 5: declarative baseline example: declared baseline for day D below shows the delclared baseline for a specific day D in month M. It is important to note that the volume submitted by the capacity provider is the expected net consumption at the delivery point that was prequalified, this is required because that is the consumption to which it will be compared.

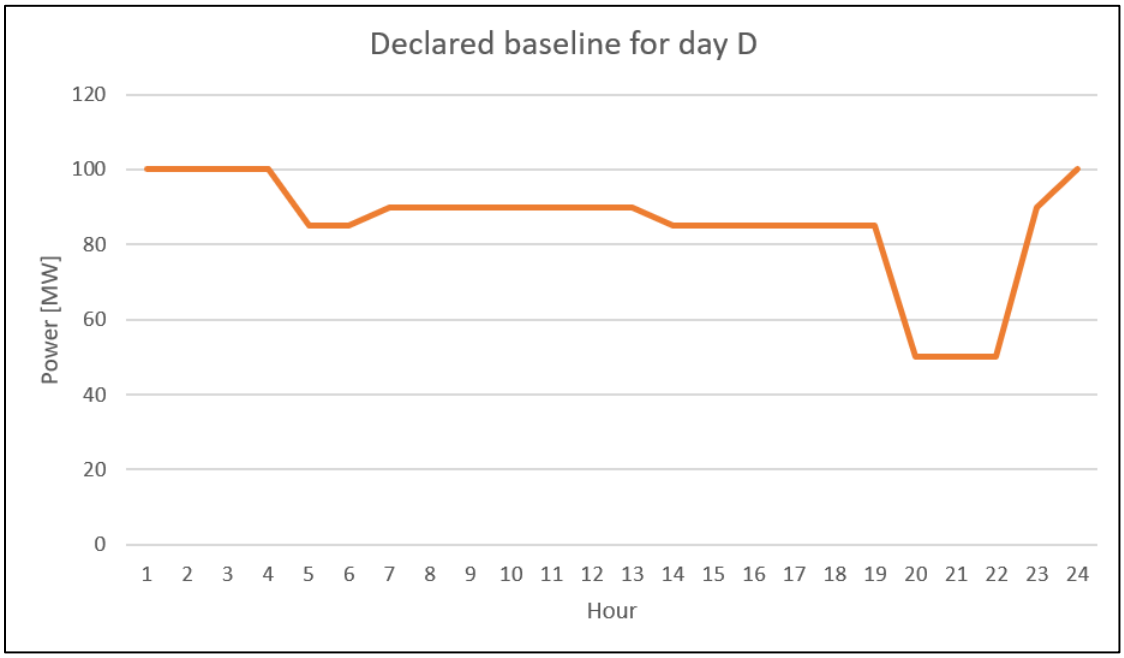

Figure 5: declarative baseline example: declared baseline for day D

In addition on this specific day D, the following prices were observed on the day-ahead market:

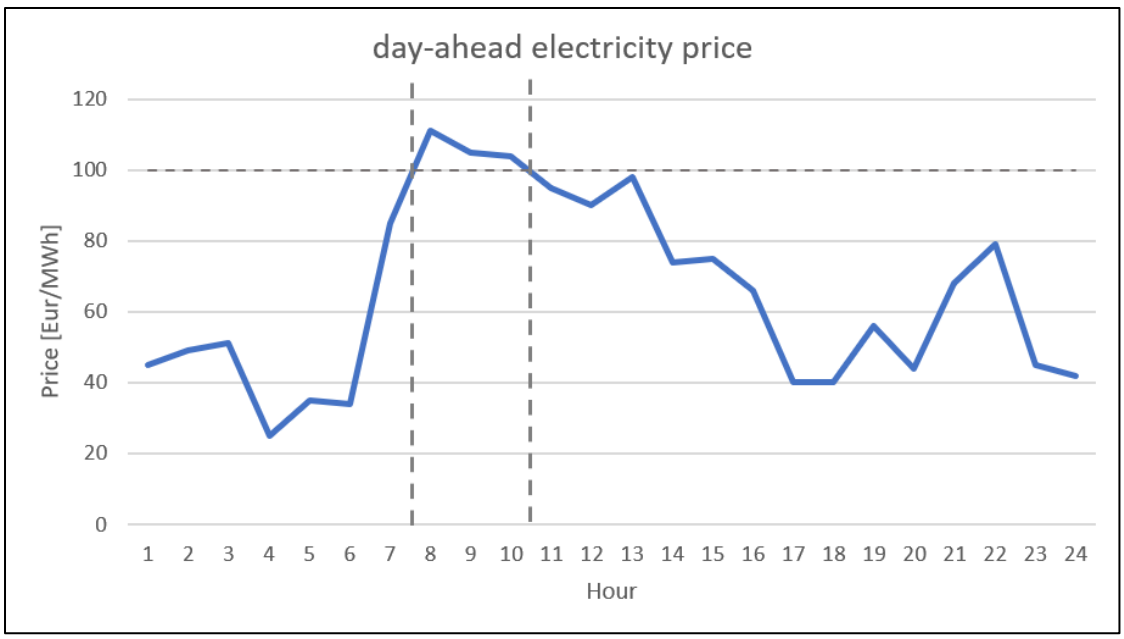

Figure 6: declarative baseline example: day-ahead price

Based on these prices, the CMU was expected to activate for three hours between 8:00 and 11:00. At the end of month M, Elia will calculate the Quality Factor of the declared baseline, which is calculated as the average Quality Factor of all days occuring in month M.

In order to calculate the Quality Factor of the example day as shown above, Elia compares the submitted declarative baseline of day D to the actual net consumption on this day. This is shown in the figure below.

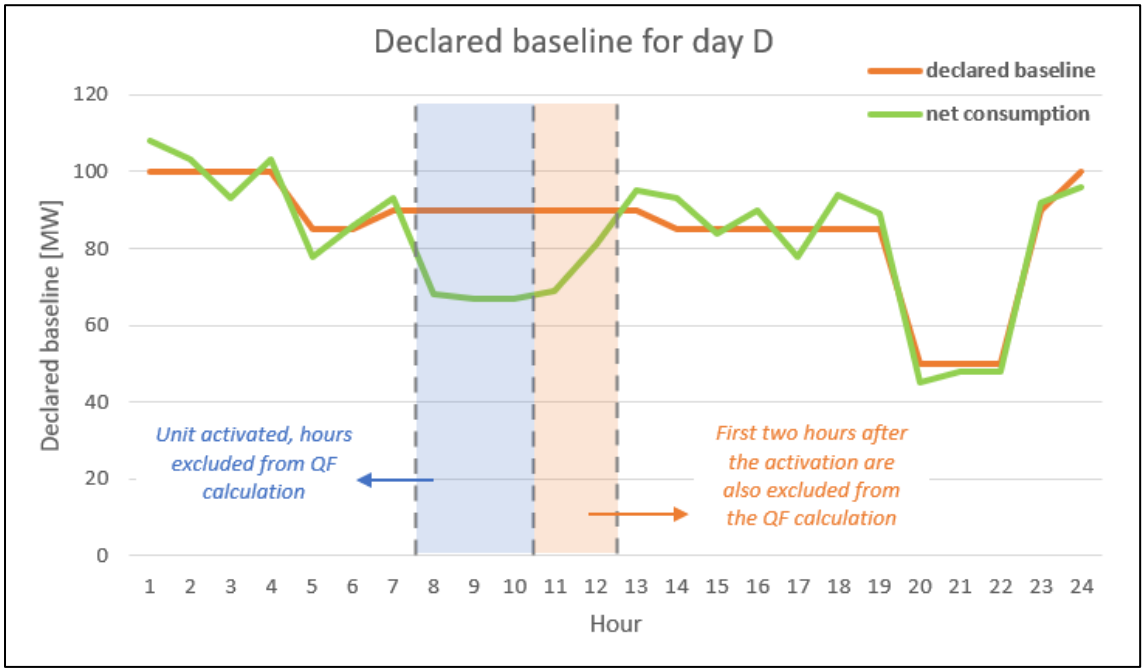

Figure 7: declarative baseline vs consumption

Based on the declared prices and the observed electricity prices on day D, Elia first excludes hours 8, 9 and 10 from this comparison. Next, Elia also excludes the first two hours following the activation in the day-ahead market: hours 11 & 12. Based on the remaining 19 hours, Elia then calculates the Quality Factor for this day, which is done as follows:

$$Quality\ Factor(DP,\ D) = 1 - \frac{RMSE(DP, D)}{Max\ (\frac{1}{N}\sum_{t\in D} P_{Baseline}(DP, t);\ 1)}$$

Where:

- $RMSE(DP, D)$ is the root mean square error for delivery point DP on day D, defined as:

$$RMSE(DP, D) = \sqrt{\frac{1}{N}\sum_{t\in D}[P_{Baseline}(DP,\ t) - P_{measured}(DP,\ t)]^2} = 5.15$$

In the formulas above, N is equal to 19 as 5 hours were excluded. RMSE(DP, D) is then equal to 5,15MW. The values shown in the figure above are summarized in Table 7: declarative baseline example values below. Based on these values, the average declared baseline turns out to be equal to 84,2MW. This then results in a Quality Factor of 93.88% for day D, which is well above the expected quality level of 80%. In the event that the

average Quality Factor of this CMU over the month also exceeded the minimum level, the submitted declarative baseline would be accepted by Elia and could be therefore be used to determine the active volume of the delivery point during AMT moments.

hour	declared baseline	consumption	activation?	included in calculation	difference square
1	100	108	FALSE	1	64
2	100	103	FALSE	1	9
3	100	93	FALSE	1	49
4	100	103	FALSE	1	9
5	85	78	FALSE	1	49
6	85	86	FALSE	1	1
7	90	93	FALSE	1	9
8	90	68	TRUE	0	0
9	90	67	TRUE	0	0
10	90	67	TRUE	0	0
11	90	69	FALSE	0	0
12	90	81	FALSE	0	0
13	90	95	FALSE	1	25
14	85	93	FALSE	1	64
15	85	84	FALSE	1	1
16	85	90	FALSE	1	25
17	85	78	FALSE	1	49
18	85	94	FALSE	1	81
19	85	89	FALSE	1	16
20	50	45	FALSE	1	25
21	50	48	FALSE	1	4
22	50	48	FALSE	1	4
23	90	92	FALSE	1	4
24	100	96	FALSE	1	16

Table 7: declarative baseline example values