Calculation of the uniform imbalance price (reBAP) across Germany's 4 LFC areas

Model description

This english translation is non binding.

Within the framework of the further development of the imbalance price system, this model will be used particularly to implement the stipulation of the Federal Network Agency BK6-21-192 of 28.04.2022 for the Imbalance Settlement Harmonization Methodology. In addition, the stipulations BK6-12-024 of 25.10.2012, as well as BK6-19-217 of 11.12.2019, BK6-19-552 of 11.05.2020 and BK6-20-345 of 11.05.2021 are other basis in terms of imbalance billing, in order to improve the management of balancing groups by the balancing responsible parties (BRPs).

The BNetzA has decided to cancel the release on the RAM (Regelarbeitsmarkt) on 31.10.2022 with decision BK6-22-162. The TSOs implemented this on the delivery date 08.12.2022. At the same time, the TSOs will take into account bids that exceed the dimensioned demand for the two bases in the AEP Module 3: The Scarcity Component.

1 Basis of calculation

The imbalance price ("AEP") as a general form of uniform imbalance price ("reBAP") is determined in a quarter-hourly time grid. Unless otherwise specified, all values mentioned below refer to a quarter of an hour.

First, in every quarter of an hour, of all four LFC areas of the German Grid Control Cooperation (GCC) the net amount of this energy (the GCC net balance position) is calculated. The GCC net balance position is formed from the positive energy input minus the negative energy input. The GCC balance ("NRV-Saldo") is calculated as follows:

$$Balance_{GCC} =$$
$$(k \cdot \Delta f)_{pos} - (k \cdot \Delta f)_{neg}$$
$$+aFRR_{Activation,pos} - aFRR_{Activation,neg} + aFRR_{Optimization,pos} - aFRR_{Optimization,neg}$$
$$+mFRR_{Activation,pos} - mFRR_{Activation,neg} + mFRR_{Optimization,pos} - mFRR_{Optimization,neg}$$
$$+additional\ measures_{pos} - additional\ measures_{neg} + Difference_{pos} - Difference_{neg}$$

$k \cdot \Delta f$	referred to as FCR.
$aFRR_{Activation}$	indicates the national activated aFRR. If aFRR volumes are activated for foreign countries, this is included as an offsetting volume in $aFRR_{Optimization}$.

$aFRR_{Optimization}$	aFRR value resulting from the optimization of PICASSO and IGCC. Here, a positive value represents an import of aFRR quantities and a negative one an export.
$mFRR_{Activaction}$	indicates the national activated mFRR. If mFRR quantities are activated for foreign countries, this is included as an offsetting volume in $mFRR_{Optimization}$.
$mFRR_{Optimization}$	mFRR value resulting from the optimization of MARI. A positive value represents an import of mFRR quantities and a negative value an export.
$additional\ measures$	The additional measures consist of, for example, of the use of capacity reserve (KapRes), disposable loads (AbLa), Intra-Day trading, the 50/100-mHz-procedure, the national network reserve and the use of emergency reserve.
$Difference$	The data point Difference is composed of the delta in the boundary integral, i.e. scheduled value – actual value (measured flow values over lines) + actual value of the interconnections. The value corresponds to the publication „difference between measured MV and scheduled flows SV over all interconnectors“ on the ENTSO-E Transparency Platform, but here in MW and with reversed sign. The schedules are ramped.

The GCC balance position is positive if the GCC LFC areas have a deficit on average within the quarter of an hour. It takes a negative value if they have a surplus. Therefore, the AEP can take on both positive and negative values.

The +/- sign of the AEP has a direct effect on the payment direction within the balancing group (BG) settlement. The following four constellations are possible in principle:

1. Positive AEP and short BG balance: BRP pays to TSO
2. Positive AEP and long BG balance: TSO pays to BRP
3. Negative AEP and short BG balance: TSO pays to BRP
4. Negative AEP and long BG balance: BRP pays to TSO

The AEP of a quarter of an hour applies to all balancing groups, regardless of whether they are short or long. An exception to this rule is the activation of capacity reserve (“Kapazitätsreserve”, KapRes) which is explained later in the chapter Capacity Reserve Regulation.

The AEP calculation steps are shown in the chart below:

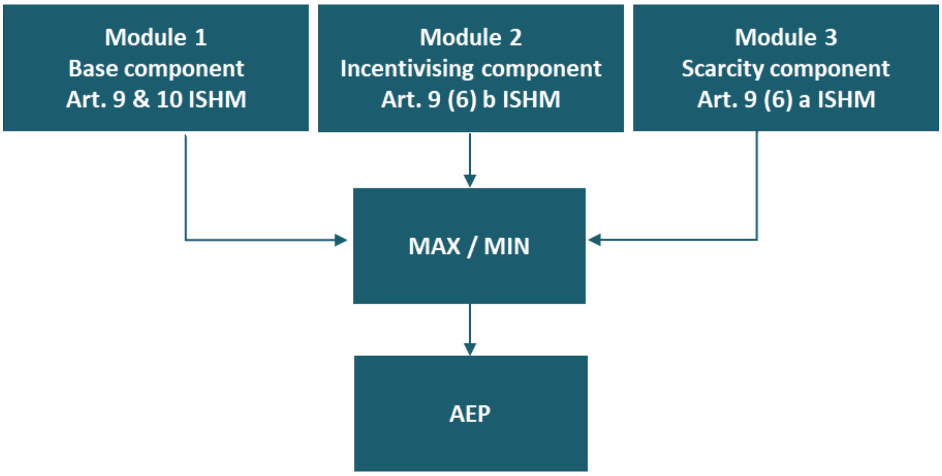

Image 1: Schematic illustration of the reBAP calculation

With a positive GCC balance (under-supply of the BG), the reBAP corresponds to the maximum of the AEP Module 1 to 3, in case of negative balance the minimum. If the GCC balance takes the value zero, modules 1 and 3 are undefined, so that only module 2 determines the reBAP.

For the calculation of the uniform imbalance price (reBAP), further framework conditions have to be taken into account, which are considered in the following chapters.

2 AEP Module 1: Base component, Inclusion of the prices of the aFRR and mFRR platforms PICASSO and MARI

Within module 1, the prices of the European balancing platforms PICASSO (platform for aFRR) and MARI (Platform for mFRR) are included in the balancing energy price. Schematically the calculation is shown in the following figure:

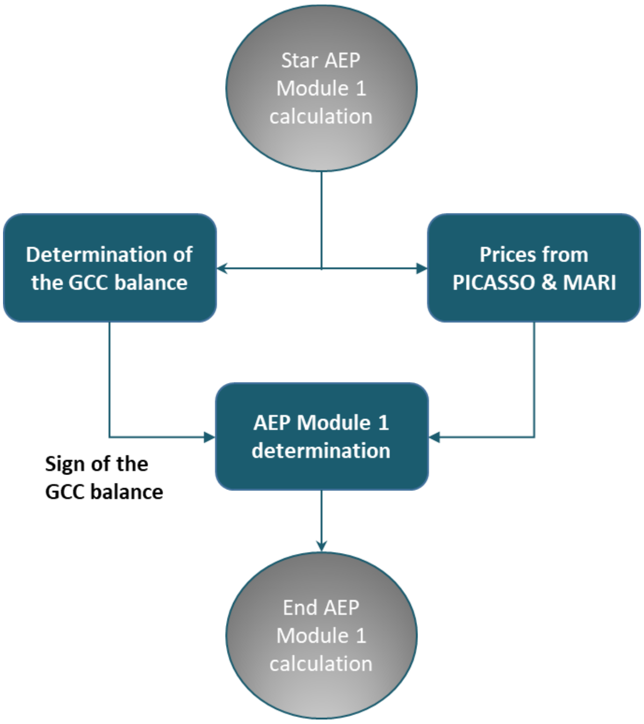

Image 2: Schematic illustration of the AEP Module 1 calculation

First, a product-specific price is calculated for each product, i.e. one price each for positive aFRR activation and mFRR activation and one price each for negative aFRR activation and mFRR activation. These prices can only be determined if there is also an activation for this product and direction.

The input variable for the two product-specific prices of the aFRR is the (cross border) marginal price (CBMP or MP) of the PICASSO platform. In case of a separation from PICASSO, national marginal prices are determined for the GCC. This MP is determined by the platform PICASSO per optimization cycle, which is 4 seconds, separately for positive and negative direction. In one optimization cycle there is one price either for the positive or the negative direction. Only in case of perfect netting both directions contain one price in one optimization cycle. The volume-weighted average value ($VWAP_{aFRR,GCC,qh}$) is calculated from all 4-second individual prices within a quarter of an hour (225 in total) for each call direction. The Satisfied Demand ($SD_{aFRR,GCC,qh}$) of PICASSO is another input variable to the AEP calculation. It is composed of the activated aFRR and the aFRR exchange quantities.

To determine the product-specific mFRR prices, prices of the schedule and direct activated mFRR have to be considered. These prices are provided by the MARI platform and are also added to the product-specific price by determining the volume-weighted average ($VWAP_{mFRR,GCC,qh}$).

In the next step, the two product-specific prices of a quarter hour per call direction determined in this way are linked to each other. This is also done by determining the VWAP of the two product-specific prices. Accordingly, $AEP1_{GCC,pos,qh}$ represents the price of positive activation and $AEP1_{GCC,neg,qh}$ the price of negative activation. In that regard, mFRR activation and mFRR exchange volumes are considered as Satisfied Demand by MARI ($SD_{mFRR,GCC,qh}$).

In addition, a case distinction is made, distinguishing between four cases when

i. there was no aFRR or mFRR activation in the associated quarter hour and therefore the VoAA (Section 2.2) must be used,
ii. no aFRR was activated in the associated quarter hour,
iii. no mFRR was activated in the corresponding quarter hour, and
iv. both aFRR and mFRR were activated in the associated quarter hour.

$$AEP1_{GCC,pos,qh} = \begin{cases} VoAA_{GCC,pos,qh} & ,VWAP_{aFRR,GCC,pos,qh} = Zero\ AND\ VWAP_{mFRR,GCC,pos,qh} = Zero \\ VWAP_{mFRR,GCC,pos,qh} & ,VWAP_{aFRR,GCC,pos,qh} = Zero\ AND\ VWAP_{mFRR,GCC,pos,qh} \neq Zero \\ VWAP_{aFRR,GCC,pos,qh} & ,VWAP_{aFRR,GCC,pos,qh} \neq Zero\ AND\ VWAP_{mFRR,GCC,pos,qh} = Zero \\ \frac{VWAP_{aFRR,GCC,pos,qh} * SD_{aFRR,GCC,pos,qh} + VWAP_{mFRR,GCC,pos,qh} * SD_{mFRR,GCC,pos,qh}}{SD_{aFRR,GCC,pos,qh} + SD_{mFRR,GCC,pos,qh}} & ,else \end{cases}$$

$$AEP1_{GCC,neg,qh} = \begin{cases} VoAA_{GCC,neg,qh} & ,VWAP_{aFRR,GCC,neg,qh} = Zero\ AND\ VWAP_{mFRR,GCC,neg,qh} = Zero \\ VWAP_{mFRR,GCC,neg,qh} & ,VWAP_{aFRR,GCC,neg,qh} = Zero\ AND\ VWAP_{mFRR,GCC,neg,qh} \neq Zero \\ VWAP_{aFRR,GCC,neg,qh} & ,VWAP_{aFRR,GCC,neg,qh} \neq Zero\ AND\ VWAP_{mFRR,GCC,neg,qh} = Zero \\ \frac{VWAP_{aFRR,GCC,neg,qh} * SD_{aFRR,GCC,neg,qh} + VWAP_{mFRR,GCC,neg,qh} * SD_{mFRR,GCC,neg,qh}}{SD_{aFRR,GCC,neg,qh} + SD_{mFRR,GCC,neg,qh}} & ,else \end{cases}$$

Formula 1: Linking of aFRR and mFRR prices

Depending on the GCC balance follows:

$$AEP_{Module\ 1} = \begin{cases} AEP1_{GCC,pos,qh} & ,Balance_{GCC} > 0 \\ AEP1_{GCC,neg,wh} & ,Balance_{GCC} < 0 \\ Zero & ,Balance_{GCC} = 0 \end{cases}$$

Formula 2: Final AEP Module 1

The AEP module 1 is then calculated by commercial rounding to two decimal places in €/MWh. In addition, when determining the AEP, attention must be paid to compliance with the price floors pursuant to Art. 55 GL EB. These and details on the VoAA are explained in more detail in the following two sections.

2.1 Lower price cap

For the formation of module 1, price limits must be taken into account in the calculation. These are defined in Article 55 (4) and (5) EB GL as follows:

(4) The imbalance price for negative imbalance shall not be less than, alternatively:
(a) the weighted average price for positive activated balancing energy from frequency restoration reserves and replacement reserves;
(b) in the event that no activation of balancing energy in either direction has occurred during the imbalance settlement period, the value of the avoided activation of balancing energy from frequency restoration reserves or replacement reserves.

(5) The imbalance price for positive imbalance shall not be greater than, alternatively:
(a) the weighted average price for negative activated balancing energy from frequency restoration reserves and replacement reserves;
(b) in the event that no activation of balancing energy in either direction has occurred during the imbalance settlement period, the value of the avoided activation of balancing energy from frequency restoration reserves or replacement reserves.

Compliance with the presented price floors is implicitly ensured by the application of volume-weighted price determination.

2.2 Value of Avoided Activation (VoAA)

The VoAA shall define an AEP for those situations where there is no FRR demand in the GCC or no activation of FRR toward the GCC requirement within a quarter hour. This price shall be appropriate as well as incentive-correct and reflect the imbalance situation in the scope of the AEP. The VoAA is therefore composed of the arithmetic mean of the first (i.e. cheapest) aFRR bid price of all optimization cycles of a quarter of an hour available for the German control areas on the PICASSO platform.

3 AEP Module 2: Incentivising component, price comparison with the German Intraday Spot Market

Module 2 is formed using the Intraday Price Index (ID AEP) which is described below. Furthermore, a minimum distance between the ID AEP and the balancing energy price is established.

For the calculation of ID AEP, all trades of the quarter-hourly product and the hourly product of continuous electricity trading on the intraday market in the market area Germany of the relevant electricity exchanges[1] are taken into account. The index of the respective settlement period includes the trades of the corresponding quarter-hourly product whose trading time has the shortest time interval from the beginning of the settlement period and whose total trading volume (V_{ID}) exactly reaches or exceeds 500 MW.
Only if the trading transactions of the quarter-hourly product do not reach a volume of 500 MW in a settlement period, the trading transactions of the hourly product which covers the settlement period and whose trading time has the shortest time interval from the beginning of the settlement period shall be supplemented to the extent that the total trading volume of the hourly products and quarter-hourly products exactly reaches or exceeds 500 MW. The volume-weighted average price is formed from the trading transactions determined in this way.

The index is not defined in a settlement period if the total volume of 500 MW is not reached. In these time periods, no imbalance price coupling takes place.

Between the ID AEP and **Module 2**, a minimum distance of 25%, but at least 10 €/MWh is established, provided that the absolute value of the GCC balance is greater than or equal to 500 MW. For a GCC net balance of 0 MW, no distance is set. In the range between 0 and 500 MW it increases linearly with the amount of the GCC balance. The minimum distance (ΔP) is thus determined as follows:

$$\Delta P = \max\left\{10\frac{€}{MWh} * \frac{\min\{125\ MWh, |Balance_{GCC}|\}}{125\ MWh}, |IDAEP| * \frac{\min\{125\ MWh, |Balance_{GCC}|\} * 0{,}25}{125\ MWh}\right\}$$

Formula 3: Calculation of the minimum distance

[1]Nominated Electricity Market Operator (NEMO) operating continuous intraday trading in the German Market Area are currently EPEX Spot SE and European Market Coupling Operator AS (NordPool AS)

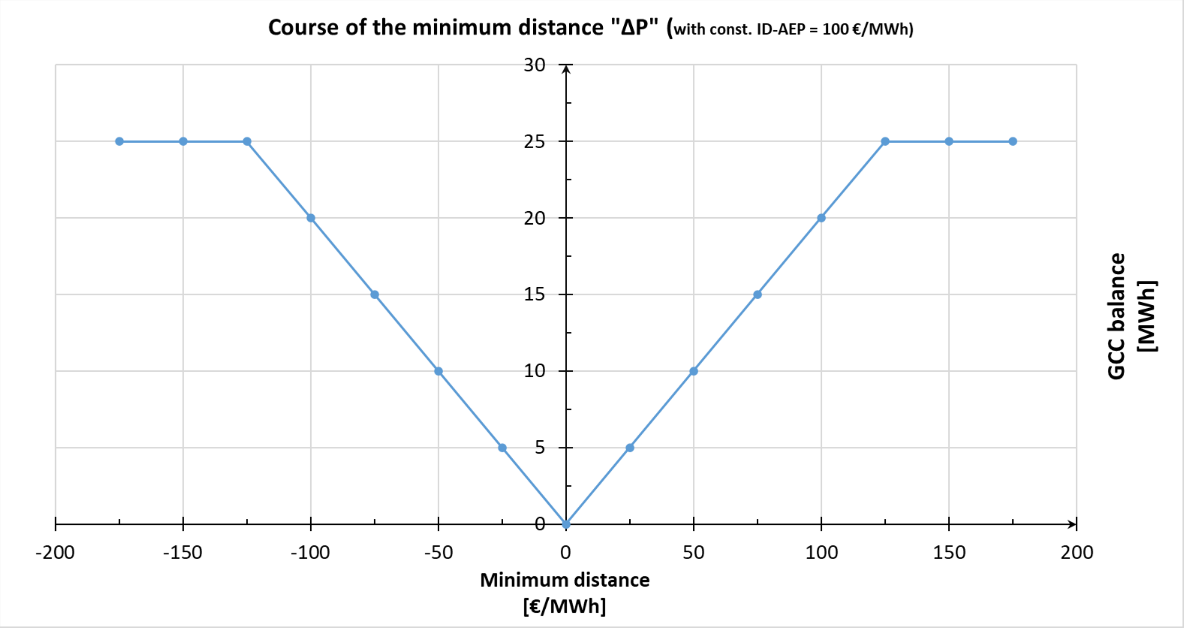

Image 3: Schematic course of the minimum distance in AEP Module 2

The Module 2 is then calculated as follows:

$$AEP_{Module2} = \begin{cases} ID\ AEP + \Delta P, Balance_{GCC} > 0\ UND\ V_{ID} \geq 500\ MW \\ ID\ AEP - \Delta P\ , Balance_{GCC} < 0\ UND\ V_{ID} \geq 500\ MW \\ ID\ AEP \qquad , Balance_{GCC} = 0\ UND\ V_{ID} \geq 500\ MW \\ \quad Zero\ resp.no\ application \qquad\qquad , else \end{cases}$$

Formula 4: Calculation of AEP Module 2

The AEP Module 2 is then calculated by commercial rounding to two decimal places in €/MWh.

4 AEP Module 3: Scarcity component

In quarter hours in which the balance of the GCC has a value of at least 80% of the dimensioned FRR for the GCC (aFRR and mFRR) plus the additional procured FRR in the corresponding direction, the scarcity component is applied. In the case of a positive balance of the GCC (undersupply), the scarcity component forms the lower limit for the reBAP for the respective quarter hour. In the case of a negative balance of the GCC (oversupply), the scarcity component forms the upper limit for the reBAP for the respective quarter hour.

The scarcity component is a second order function (parabolic curve) as a function of the balance of the GCC.

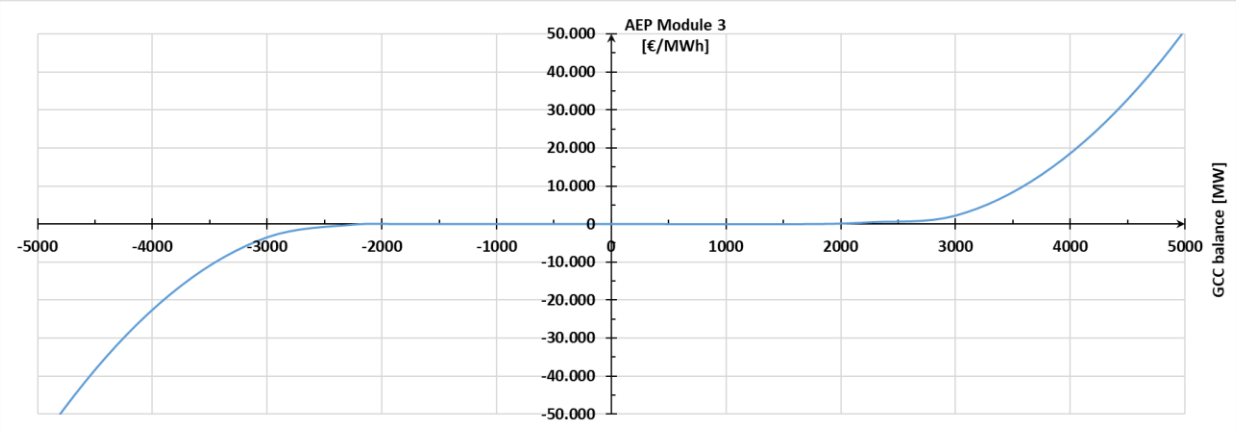

Image 4: Schematic course of the scarcity component

The function term is calculated as follows:

$$AEP_{Module3} = \begin{cases} f_{short,pos} & , Balance_{GCC} \geq P_{db,pos} \\ f_{short,neg} & , Balance_{GCC} \leq P_{db,neg} \\ Zero\ resp.\ no\ application & , else \end{cases}$$

Formula 5: Calculation of AEP Module 3

Whereas

$$f_{short,pos} = \begin{cases} AEP_{Module2} + (2 * BP_{cap} - AEP_{Module2}) * \left(\frac{Balance_{GCC} - P_{db,pos}}{P_{Res,pos} - P_{db,pos}}\right)^2 & , if\ AEP_{Module2} \neq Zero \\ 2 * BP_{cap} * \left(\frac{Balance_{GCC} - P_{db,pos}}{P_{Res,pos} - P_{db,pos}}\right)^2 & , else \end{cases}$$

$$f_{short,neg} = \begin{cases} AEP_{Module2} + (-2 * BP_{cap} - AEP_{Module2}) * \left(\frac{Balance_{GCC} - P_{db,neg}}{P_{Res,neg} - P_{db,neg}}\right)^2 & , if\ AEP_{Module2} \neq Zero \\ -2 * BP_{cap} * \left(\frac{Balance_{GCC} - P_{db,neg}}{P_{Res,neg} - P_{db,neg}}\right)^2 & , else \end{cases}$$

$$P_{db,pos} = 0.8 * \sum\left(P_{aFRR,pos} + P_{mFRR,pos}\right),$$
$$P_{RES,pos} = \sum(P_{aFRR,pos} + P_{mFRR,pos} + P_{capres}),$$
$$P_{db,neg} = -0.8 * \sum(P_{aFRR,neg} + P_{mFRR,neg}),$$
$$P_{RES,neg} = -\sum(P_{aFRR,neg} + P_{mFRR,neg} + P_{capres}).$$

Whereas

BP_{cap}	Highest permissible bid price in intraday exchange trading
$Balance_{GCC}$	Balance of the German Control Cooperation
$P_{db,pos}$	Dead band in case of shortfall. This corresponds to 80 % of the dimensioned positive aFRR and mFRR.
$P_{db,neg}$	Dead band in case of surplus. This corresponds to 80 % of the dimensioned negative aFRR and mFRR.
$P_{Res,pos}$	Sum of the dimensioned positive FRR plus the contracted capacity reserve and the additional procured FRR.
$P_{Res,neg}$	Negated sum of the dimensioned negative FRR plus the negated sum of the contracted capacity reserve and the additional procured FRR.
$P_{aFRR,pos}$	Power of the dimensioned positive aFRR and the additional procured FRR
$P_{aFRR,neg}$	Power of the dimensioned negative aFRR and the additional procured FRR
$P_{mFRR,pos}$	Power of the dimensioned positive mFRR and the additional procured FRR
$P_{mFRR,neg}$	Power of the dimensioned negative mFRR and the additional procured FRR

Please note:

- In quarter hours in which the balance of the GCC has a value of less than 80 % of dimensioned FRR for the German LFC block in the corresponding direction, the scarcity component has no effect.

The AEP Module 3 is then calculated by commercial rounding to two decimal places in €/MWh.

5 Capacity Reserve Regulation

In the case of a capacity reserve activation, the AEP for balancing group deficit is at least twice the highest permissible bid price in intraday exchange trading (currently 2*9,999 €/MWh = 19,998 €/MWh) in the respective quarter hour, provided that the requirements from §32 Capacity Reserve Regulation (“KapResV”) are met. These stipulate that the balance of the GCC in the corresponding quarter hour must be greater than the total available positive aFRR and mFRR and that an activation has been made in accordance with § 26 KapResV. As a result, in the case of application according to § 32 (2) for balancing group surplus, if necessary, an AEP deviating from the steps described above is settled and the calculated reBAP becomes asymmetrical for the respective quarter hour. If the AEP in the corresponding quarter hour is greater than twice the maximum bid price allowed in intraday exchange trading ($Pr_{ID.Limit}$; currently 19,998 €/MWh), this will, however, continue to apply symmetrically for balancing group surplus and deficit. Accordingly, the AEP is only determined in the case of a capacity reserve activation pursuant to § 32 (2) and § 26 KapResV, respectively, and is then calculated as follows:

$$reBAP_{neg} = \begin{cases} \max(AEP_{Module1}; AEP_{Module2}; AEP_{Module3}) & , Balance_{GCC} > 0 \\ \min(AEP_{Module1}; AEP_{Module2}; AEP_{Module3}) & , Balance_{GCC} < 0 \\ AEP_{Module2} & , Balance_{GCC} = 0 \end{cases}$$

$$reBAP_{pos} = \begin{cases} \max\left(reBAP_{neg}, Pr_{ID.Limit} * 2\right) & , P_{Abruf.KapRes} > 0 \; UND \; Balance_{GCC} > P_{aFRR,pos} + P_{mFRR,pos} \\ reBAP_{neg} & , else \end{cases}$$

Formula 6: Effects of capacity reserve activation according to KapResV to the AEP calculation

6 Offsetting of deficits and surpluses

The AEP is determined in 3 modules, whereby the AEP results from the maximum value (in the event of a shortfall in the GCC) or minimum value (in the event of a surplus in the GCC) of the modules. The revenues generated by the TSOs through balancing group settlement with the AEP are offset by the costs for the balancing measures used (essentially the costs of the control energy activations). This can result in both financial deficits and surpluses for the TSOs. These deficits and surpluses are added up by the TSOs on a calendar-year basis and included in the determination of the network usage charges (“Netznutzungsentgelte, NNE”). In this way, the TSOs are placed in a financially neutral position and the deficits / surpluses have an NNE-increasing / NNE-reducing effect.