European Network of Transmission System Operators for Electricity

entsoe

Quarterly Report Q2/2023 according to article 9(4) of the common methodology for the pricing of balancing energy and cross-border capacity

21 August 2023

From: ENTSO-E

ENTSO-E Mission Statement

Who we are

ENTSO-E, the European Network of Transmission System Operators for Electricity, is the association for the cooperation of the European transmission system operators (TSOs). The 39 member TSOs, representing 35 countries, are responsible for the secure and coordinated operation of Europe's electricity system, the largest interconnected electrical grid in the world. In addition to its core, historical role in technical cooperation, ENTSO-E is also the common voice of TSOs.

ENTSO-E brings together the unique expertise of TSOs for the benefit of European citizens by keeping the lights on, enabling the energy transition, and promoting the completion and optimal functioning of the internal electricity market, including via the fulfilment of the mandates given to ENTSO-E based on EU legislation.

Our mission

ENTSO-E and its members, as the European TSO community, fulfil a common mission: Ensuring the security of the inter-connected power system in all time frames at pan-European level and the optimal functioning and development of the European interconnected electricity markets, while enabling the integration of electricity generated from renewable energy sources and of emerging technologies.

Our vision

ENTSO-E plays a central role in enabling Europe to become the first climate-neutral continent by 2050 by creating a system that is secure, sustainable and affordable, and that integrates the expected amount of renewable energy, thereby offering an essential contribution to the European Green Deal. This endeavour requires sector integration and close cooperation among all actors.

Europe is moving towards a sustainable, digitalised, integrated and electrified energy system with a combination of centralised and distributed resources. ENTSO-E acts to ensure that this energy system keeps consumers at its centre and is operated and developed with climate objectives and social welfare in mind.

ENTSO-E is committed to use its unique expertise and system-wide view – supported by a responsibility to maintain the system's security – to deliver a comprehensive roadmap of how a climate-neutral Europe looks.

Our values

ENTSO-E acts in solidarity as a community of TSOs united by a shared responsibility.

As the professional association of independent and neutral regulated entities acting under a clear legal mandate, ENTSO-E serves the interests of society by optimising social welfare in its dimensions of safety, economy, environment, and performance.

ENTSO-E is committed to working with the highest technical rigour as well as developing sustainable and innovative responses to prepare for the future and overcoming the challenges of keeping the power system secure in a climate-neutral Europe. In all its activities, ENTSO-E acts with transparency and in a trustworthy dialogue with legislative and regulatory decision makers and stakeholders.

Our contributions

ENTSO-E supports the cooperation among its members at European and regional levels. Over the past decades, TSOs have undertaken initiatives to increase their cooperation in network planning, operation and market integration, thereby successfully contributing to meeting EU climate and energy targets.

To carry out its legally mandated tasks, ENTSO-E's key responsibilities include the following:

› Development and implementation of standards, network codes, platforms and tools to ensure secure system and market operation as well as integration of renewable energy;

› Assessment of the adequacy of the system in different timeframes;

› Coordination of the planning and development of infrastructures at the European level (Ten-Year Network Development Plans, TYNDPs);

› Coordination of research, development and innovation activities of TSOs;

› Development of platforms to enable the transparent sharing of data with market participants.

ENTSO-E supports its members in the implementation and monitoring of the agreed common rules.

ENTSO-E is the common voice of European TSOs and provides expert contributions and a constructive view to energy debates to support policymakers in making informed decisions.

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1. Background of the report

According to its decision 03/2022[1] published in February 2022[2], ACER has amended the methodology for pricing balancing energy and cross-zonal capacity used for the exchange of balancing energy or operating the imbalance netting process in accordance with Article 30(1) of Commission Regulation (EU) 2017/2195 establishing a guideline on electricity balancing ('Balancing Pricing Methodology' hereafter)[3].

As a main element, article 9(3) of the amended Balancing Pricing Methodology introduces a transitory upper price limit of 15 000 EUR/MWh and a transitory lower price limit of – 15 000 EUR/MWh for the first 4 years of the European balancing platforms' operations, until July 2026.[4] These price limits apply for the TSOs participating in the RR-Platform from 1 July 2022.

Furthermore, article 9(4) of the amended Balancing Pricing Methodology requires all TSOs to report to ACER and regulatory authorities on quarterly basis on the balancing energy price formation during the transitional period (see above). In particular, all TSOs have to submit the following indicators:

a) monthly average values of used and available cross-zonal capacity for the exchange of balancing energy per each bidding zone border and direction;

b) average percentage of both submitted and activated standard balancing energy bids per product and per direction with prices higher (and lower) than 50%, 75%, 90%, 95% and 99% of the upper (and lower) transitional price limit;

c) volume weighted average price of the last (most expensive) 5% of the volume of submitted standard balancing energy bids for each European balancing platform per direction and per participating TSO;

In addition, it was agreed with ACER and regulatory authorities to include the analysis of the pricing incidents according to article 9(5) of the amended Balancing Pricing Methodology in the quarterly reports. By the present report, all TSOs fulfil the obligations according to article 9(4) of the amended Balancing Pricing Methodology.

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[1] *ACER decision 03/2022:*
https://www.acer.europa.eu/sites/default/files/documents/Individual%20Decisions/ACER%20Decision%2003-2022%20on%20the%20Amendment%20to%20the%20Methodology%20for%20Pricing%20Balancing%20Energy_0.pdf

[2] *Press release by ACER:*
https://www.acer.europa.eu/events-and-engagement/news/acer-has-decided-amendment-common-pricing-methodology-european

[3] *Amendment of Balancing Pricing Methodology:*
https://www.acer.europa.eu/sites/default/files/documents/Individual%20Decisions_annex/ACER%20Decision%2003-2022%20on%20the%20amendment%20of%20the%20pricing%20methodology%20-%20Annex%20I_0.pdf

[4] *If the harmonised maximum clearing price for the single intraday coupling in accordance with Article 54(1) of Commission Regulation (EU) 2015/1222 increases above 9,999 €/MWh, the transitional upper price limit in accordance with subparagraph (a) shall automatically increase by the same amount. In this case, the transitional lower price limit shall be decreased to the same absolute value.*

2. Scope of the report

This report covers the operational period from 1 April to 30 June 2023 for the European balancing platforms PICASSO, MARI, and TERRE in line with the requirements stipulated in the amended Pricing Methodology.

3. Indicators of the balancing energy price formation

3.1 Monthly average values of used and available cross-zonal capacity for the exchange of balancing energy

The monthly average values of used and available cross-zonal capacity (CZC) for the exchange of balancing energy are calculated for each balancing energy platform per bidding zone border in both directions. Please note that the calculation of monthly average values does not allow to draw specific conclusions about the availability of CZC in single MTUs. Please note also that the use of CZC from A to B does not distinguish between fulfilment of an upward balancing energy demand in B or fulfilment of a downward balancing energy demand in A.

Legal reference	Article 9(4) of the common methodology for the pricing of balancing energy and cross-border capacity
Data source	aFRR, mFRR and RR platforms
Calculation	1. CZC available per BZ border and direction for the aFRR/mFRR/RR exchange 2. CZC used per BZ border and direction for the aFRR/mFRR/RR exchange

1) PICASSO - Monthly average values of used and available CZC

	April 2023		May 2023		June 2023	
	Available CZC	Used CZC	Available CZC	Used CZC	Available CZC	Used CZC
DE->CZ	685	28	570	29	779	24
CZ->DE	700	26	544	15	583	20
DE->AT	601	45	703	47	706	38
AT->DE	667	51	424	40	500	47
CZ->AT	278	17	748	25	600	16
AT->CZ	379	26	143	15	145	15

Table 1: PICASSO – Monthly average values of used and available cross-zonal capacity for the exchange of aFRR [MW]

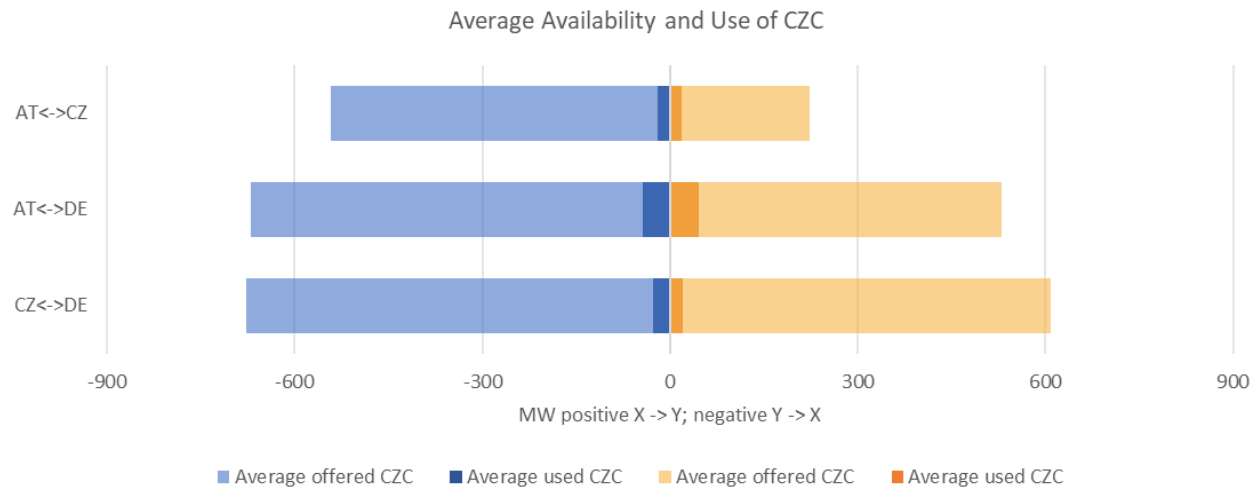

Figure 1: PICASSO – Average used and available cross-zonal capacity for the exchange of aFRR [MW]

2) MARI – Monthly average values of used and available CZC

	April 2023		May 2023		June 2023	
	Available CZC	**Used CZC**	**Available CZC**	**Used CZC**	**Available CZC**	**Used CZC**
CZ->DE	712	0.1	641	0.1	571	0.2
DE->CZ	726	0.1	660	0.2	792	0.1
CZ->AT	n/a	n/a	n/a	n/a	6.5	-
AT->CZ	n/a	n/a	n/a	n/a	5.9	-
AT->DE	n/a	n/a	n/a	n/a	5.8	-
DE->AT	n/a	n/a	n/a	n/a	6.7	-

Table 2: MARI – Monthly average values of used and available cross-zonal capacity for the exchange of mFRR [MW]

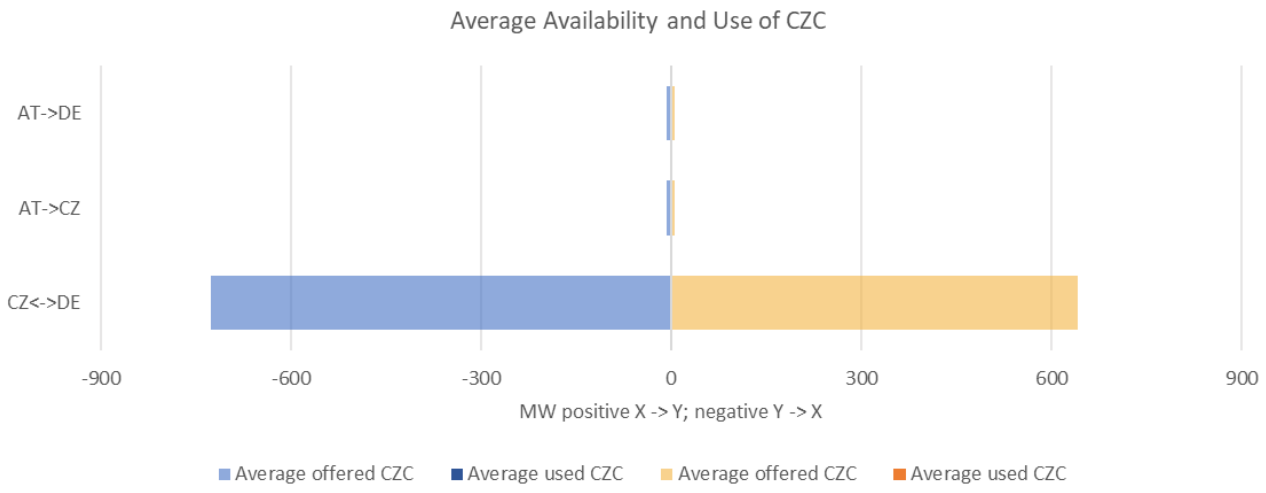

Figure 2: MARI – Average used and available cross-zonal capacity for the exchange of mFRR [MW]

3) TERRE - Monthly average values of used and available CZC

	April 2023		May 2023		June 2023	
	Available CZC	**Used CZC**	**Available CZC**	**Used CZC**	**Available CZC**	**Used CZC**
ES->FR	352	166	388	165	394	151
ES->PT	1 920	197	1 696	192	2 207	244
FR->ES	461	141	417	185	382	151
FR->CH	1 087	97	636	84	1 312	102
FR->IT	813	109	334	75	984	73
CH->FR	3 024	148	299	123	3 000	148
CH->IT	463	88	3 328	56	497	68
IT->FR	3 608	58	3 243	92	3 088	142
IT->CH	4 621	90	4 215	62	3 891	77
PT->ES	4 765	276	4 558	283	3 859	179

Table 3: TERRE – Monthly average values of used and available cross-zonal capacity for the exchange of RR [MW]

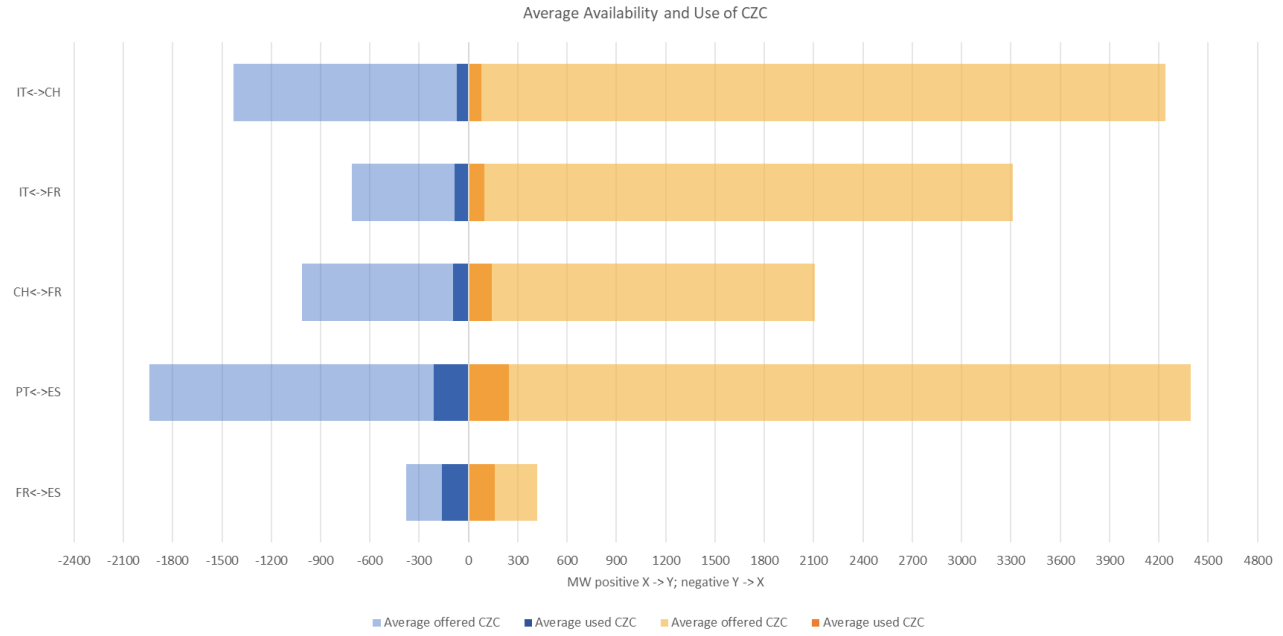

Figure 3: TERRE– Average used and available cross-zonal capacity for the exchange of RR [MW]

3.2 Average percentage of submitted and activated standard balancing energy bids compared the upper (and lower) transitional price limit

This PI calculates the average percentage of all submitted (CMOL) and selected standard balancing energy bids on a monthly basis. In total, 20 values are to be reported per platform: five values (50%, 75%, 90%, 95% and 99%) in upward and respectively in downward direction for a) submitted and b) selected balancing energy bids.

Legal reference	Article 9(4) of the common methodology for the pricing of balancing energy and cross-border capacity
Data source	aFRR, mFRR and RR platforms
Calculation	1. Submitted upward balancing energy bids with prices higher than [50%, 75%, 90%, 95%, 99%] of the transitional price limit 2. Submitted downward balancing energy bids with prices lower than [50%, 75%, 90%, 95%, 99%] of the transitional price limit 3. Upward balancing energy with prices higher than [50%, 75%, 90%, 95%, 99%] of the transitional price limit 4. Downward balancing energy with prices lower than [50%, 75%, 90%, 95%, 99%] of the transitional price limit

1) PICASSO – Average percentage of submitted aFRR bids with prices more expensive than 50%, 75%, 90%, 95% and 99% of the transitional price limit

	Positive aFRR					Negative aFRR				
Threshold	**50%**	**75%**	**90%**	**95%**	**99%**	**50%**	**75%**	**90%**	**95%**	**99%**
April 2023	6.0%	4.7%	4.4%	4.4%	4.3%	7.1%	5.5%	5.0%	4.8%	4.5%
May 2023	6.9%	5.0%	4.9%	4.7%	4.6%	6.5%	4.9%	4.6%	4.4%	4.1%
June 2023	7.7%	5.2%	5.0%	4.8%	4.7%	7.3%	5.4%	5.0%	4.7%	4.4%

Table 4: PICASSO – Average percentage of submitted bids over certain price limits

2) PICASSO – Average percentage of selected aFRR bids with prices more expensive than 50%, 75%, 90%, 95% and 99% of the transitional price limit

	Positive aFRR					Negative aFRR				
Threshold	**50%**	**75%**	**90%**	**95%**	**99%**	**50%**	**75%**	**90%**	**95%**	**99%**
April 2023	0.045%	0.032%	0.032%	0.032%	0.031%	0.131%	0.066%	0.052%	0.045%	0.036%
May 2023	0.101%	0.057%	0.053%	0.053%	0.046%	0.108%	0.006%	0.004%	0.004%	0.004%
June 2023	0.060%	0.022%	0.021%	0.021%	0.021%	0.044%	0.007%	0.007%	0.006%	0.006%

Table 5: PICASSO – Average percentage of selected bids over certain price limits

3) MARI – Average percentage of submitted mFRR bids with prices more expensive than 50%, 75%, 90%, 95% and 99% of the transitional price limit

	Positive mFRR					Negative mFRR				
Threshold	**50%**	**75%**	**90%**	**95%**	**99%**	**50%**	**75%**	**90%**	**95%**	**99%**
April 2023	22.6%	17.8%	15.6%	14.0%	12.5%	22.9%	14.6%	11.4%	9.1%	8.2%
May 2023	21.9%	18.5%	14.3%	13.6%	12.7%	19.4%	15.4%	13.4%	11.0%	8.3%
June 2023	24.5%	16.7%	16.1%	14.1%	13.6%	20.1%	13.8%	12.3%	9.5%	8.0%

Table 6: MARI – Average percentage of submitted bids over certain price limits

4) MARI – Average percentage of selected mFRR bids with prices more expensive than 50%, 75%, 90%, 95% and 99% of the transitional price limit

	Positive mFRR					Negative mFRR				
Threshold	**50%**	**75%**	**90%**	**95%**	**99%**	**50%**	**75%**	**90%**	**95%**	**99%**
April 2023	-	-	-	-	-	5.65%	2.34%	2.34%	2.34%	2.34%
May 2023	-	-	-	-	-	-	-	-	-	-
June 2023	3.21%	-	-	-	-	8.76%	8.76%	8.76%	8.76%	8.76%

Table 7: MARI – Average percentage of selected bids over certain price limits

5) TERRE – Average percentage of submitted RR bids with prices more expensive than 50%, 75%, 90%, 95% and 99% of the transitional price limit

	Positive RR					Negative RR				
Threshold	**50%**	**75%**	**90%**	**95%**	**99%**	**50%**	**75%**	**90%**	**95%**	**99%**
April 2023	3.2%	1.2 %	0.6%	0.6%	0.3%	0.6%	0.6 %	0.5%	0.5%	0.5%
May 2023	1.5%	0.5%	0.5%	0.5 %	0.2%	0.5%	0.3%	-	-	-
June 2023	0.7%	0.7 %	0.7%	0.7%	0.7%	1.6%	1.2%	1.1%	1.1%	1.1%

Table 8: TERRE – Average percentage of submitted bids over certain price limits

6) TERRE – Average percentage of selected RR bids with prices more expensive than 50%, 75%, 90%, 95% and 99% of the transitional price limit

	Positive RR					Negative RR				
Threshold	**50%**	**75%**	**90%**	**95%**	**99%**	**50%**	**75%**	**90%**	**95%**	**99%**
April 2023	-	-	-	-	-	-	-	-	-	-
May 2023	-	-	-	-	-	-	-	-	-	-
June 2023	-	-	-	-	-	-	-	-	-	-

Table 9: TERRE – Average percentage of selected bids over certain price limits

3.3 Volume weighted average price of the most expensive balancing energy bids

The VWAP of the last 5% of the submitted bids per platform, per direction and per participating TSO is calculated on a monthly basis. Each balancing platform provides two values per connected TSO, one for upward and one for downward direction.

Legal reference	Article 9(4) of the common methodology for the pricing of balancing energy and cross-border capacity
Data source	aFRR, mFRR and RR platforms
Calculation	1. VWAP of the last 5% of the upward balancing energy bids submitted per TSO connected to the platform 2. VWAP of the last 5% of the downward balancing energy bids submitted per TSO connected to the platform

1) PICASSO – VWAP of the 5% most expensive aFRR bids submitted

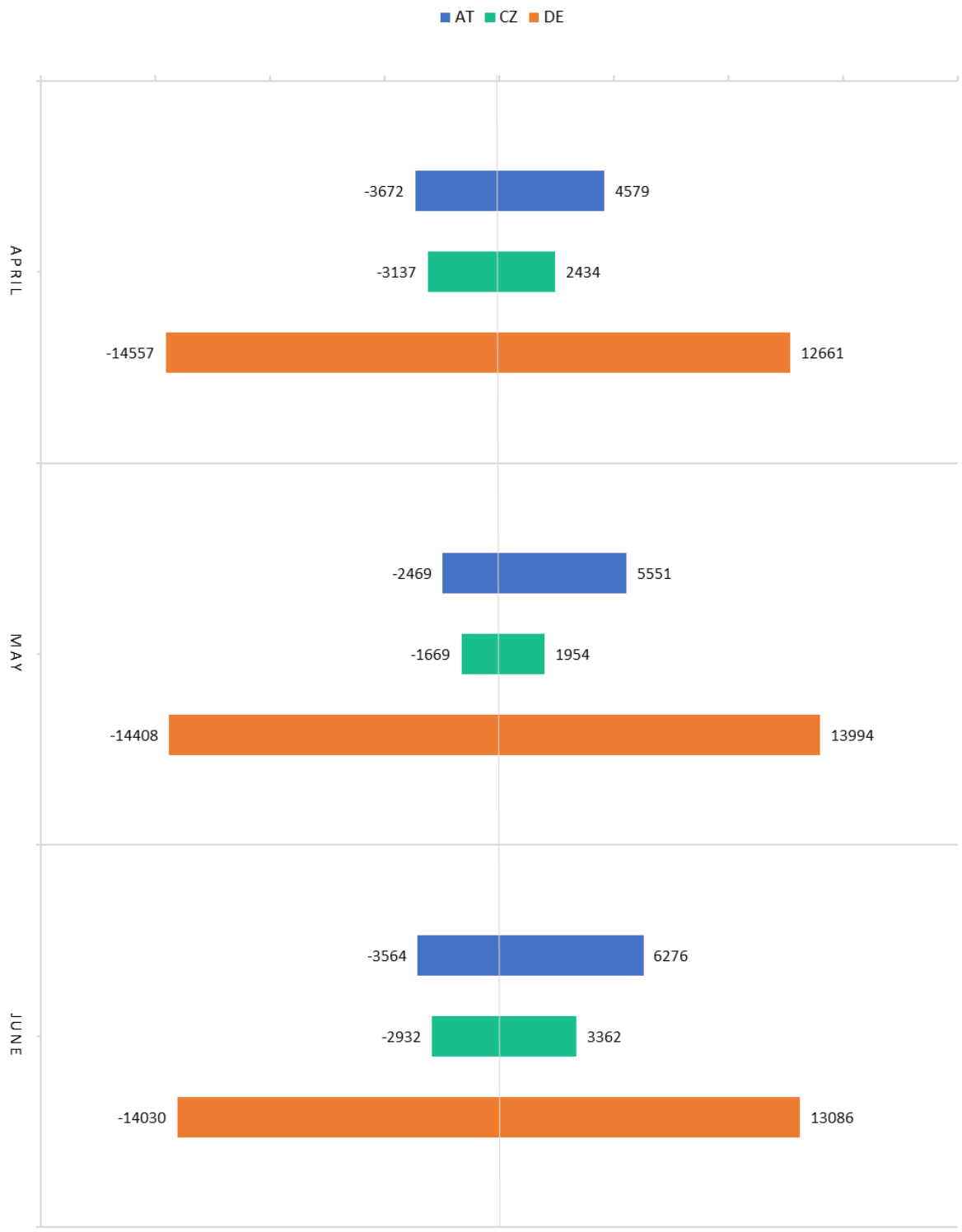

Figure 4: PICASSO - VWAP of the 5% most expensive aFRR bids submitted [EUR/MWh] per country

2) MARI – VWAP of the 5% most expensive mFRR bids submitted

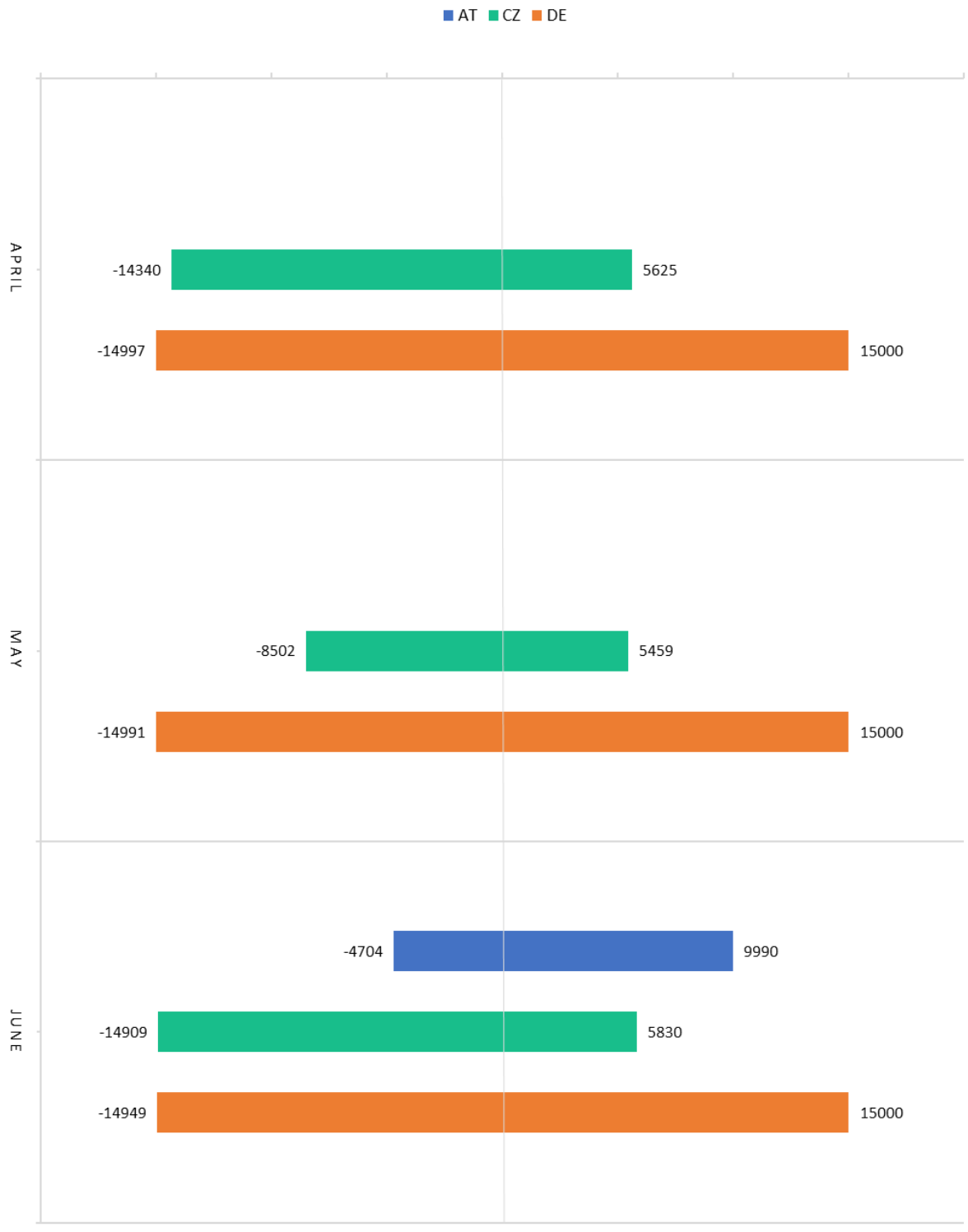

Figure 5: MARI - VWAP of the 5% most expensive mFRR bids submitted [EUR/MWh] per country

3) TERRE – VWAP of the 5% most expensive RR bids submitted

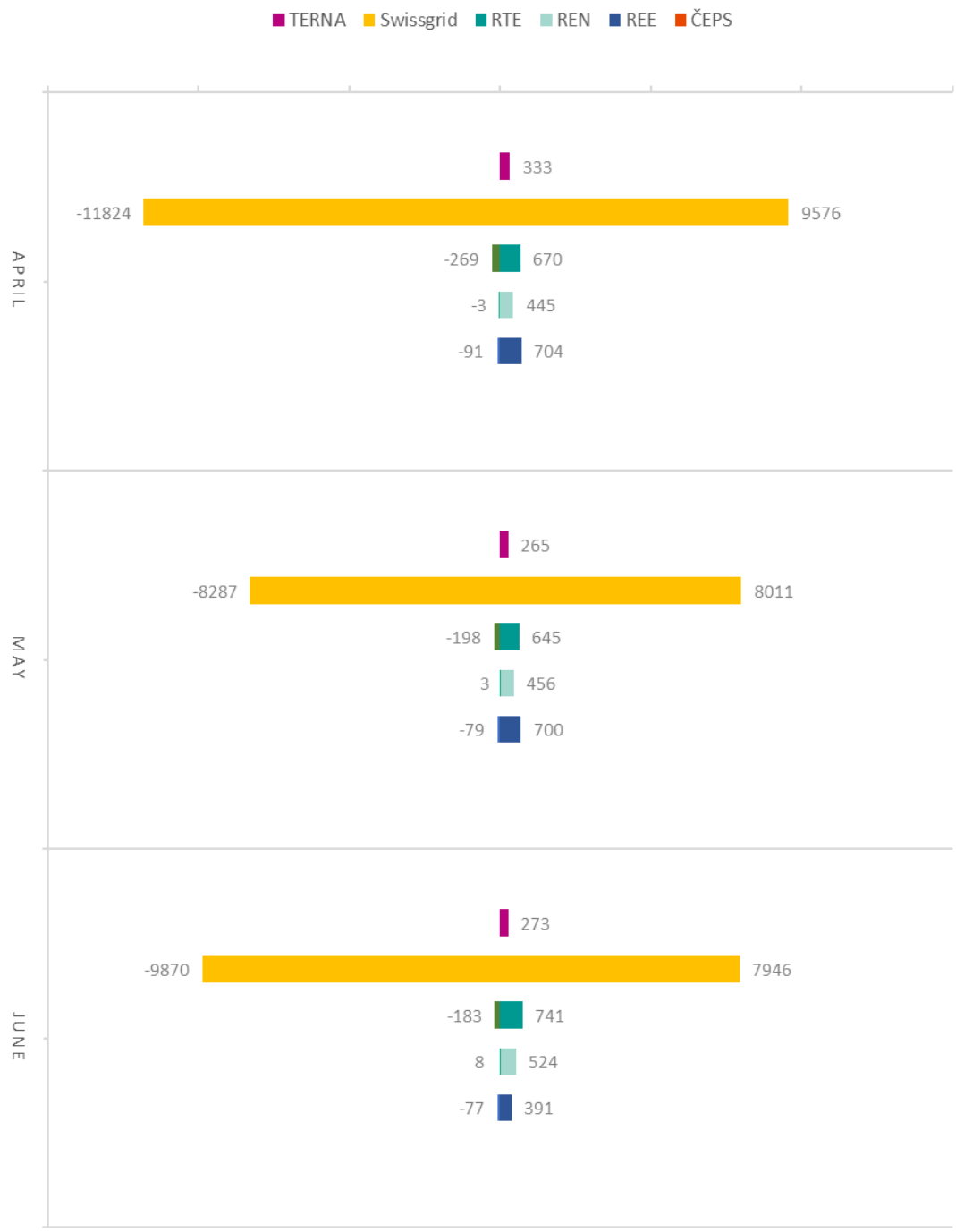

Figure 6: TERRE - VWAP of the 5% most expensive RR bids submitted [EUR/MWh] per country

4. Analysis of the price incidents

In accordance with Article 9(3) of the amended Balancing Pricing Methodology, all TSOs have to prepare a joint report whenever the CBMP reaches at least 50% of the minimum or maximum transitional price limit. Such a price incident is triggered whenever the threshold has been reached in at least one MTU (referred to as "event"). All events within one 15-min period are grouped into one incident if they cover the same uncongested area. For TERRE and MARI this equals one market-time unit (MTU). For PICASSO several events can take place within one 15-min incident period as the MTU equals 4 sec (i.e., an incident in PICASSO can be of duration from 4 sec to 15 min). All TSOs chose this approach for PICASSO as the bid structure and therefore the CMOL remain the same for the 15-min period.

4.1 Analysis of the aFRR pricing spikes

In total 129 price incidents occurred between 1 April and 30 June 2023 in the aFRR market, 27 in positive direction and 102 in negative direction. This reflects a stable development of incidents, no significant changes in the number can be overserved over time since the go-live of the aFRR platform.

1. Majority of incidents occur in negative direction

Similar to the distribution of price incidents during the past quarters, majority of the aFRR incidents in Q2 2023, i.e., 79 %, occurred in negative direction.

2. Number of incidents for Austria remain high, involvement of Czech Republic forming an affected uncongested area decreases compared to Q1 2023

Since platform operation, majority of incidents have occurred with Austria forming part of the affected uncongested area and in many cases even being the only country affected by a price incident. In Q2 2023, Austria formed in 48% of all incidents alone the uncongested area, Germany in 12% of all incident cases and Czech Republic in 4%. Compared to Q1 2023 this implies a decrease in the number of incidents for which Czech Republic as single uncongested area triggered a price incident. For Austria and Germany the numbers remain more or less constant.

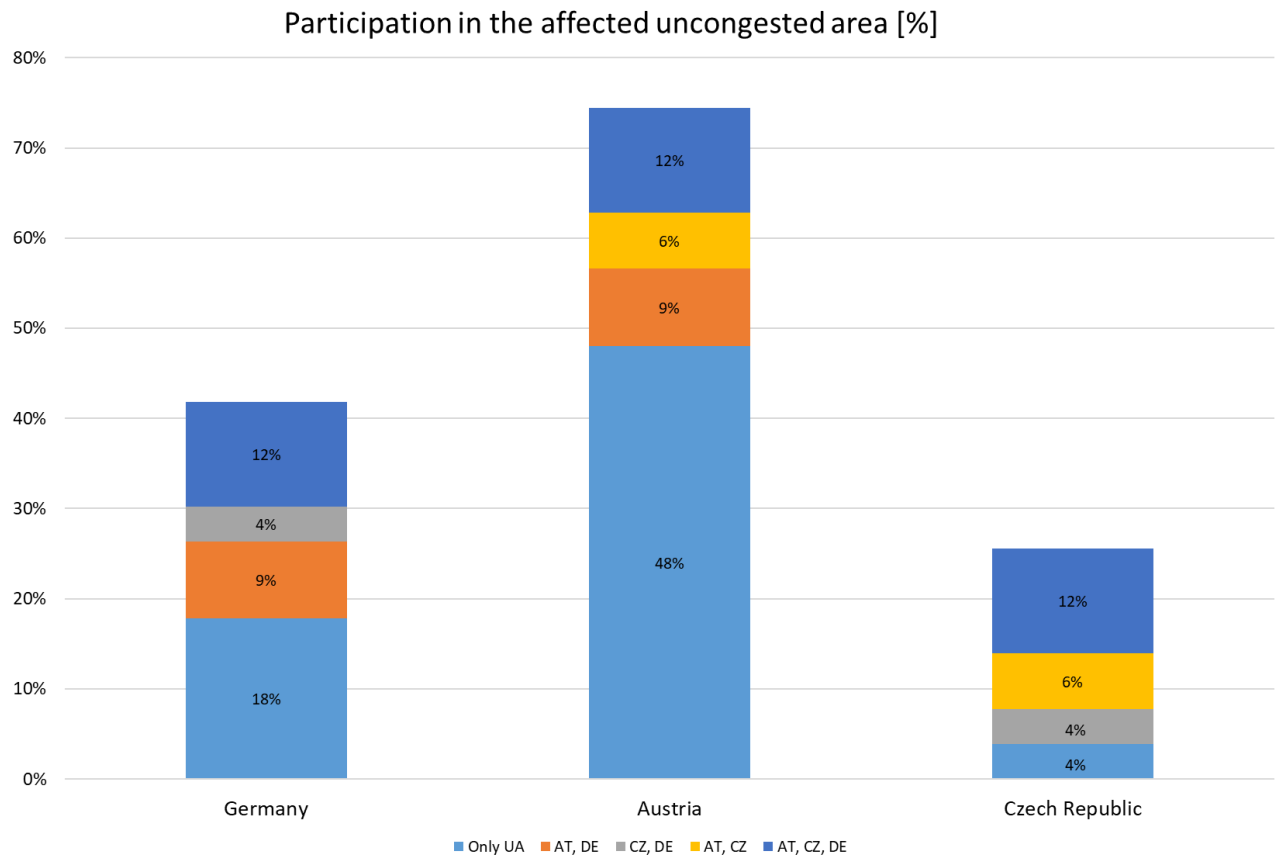

Figure 7: Country participation in the uncongested area affected by an aFRR price incident

3. Incidents are largely triggered at a CBMP below the 15 000 EUR/MWh price cap

As already observed in the past quarters since operation, majority of the price incidents occur at a CBMP below the temporary price cap of +/- 15 000 EUR/MWh. Only 30% of all incidents reach the maximum possible clearing price. Majority of the remaining incidents are triggered at 10 000 EUR/MWh in positive direction and at -9 200 EUR/MWh in negative direction (Figure 8 and 9). These "thresholds" have already been observed in Q1 2023. While the 10 000 EUR/MWh threshold can be explained by the ex-post effects of the sunshine rule previously applied in Austria, no suitable explanation can be found for the clustered bidding behaviour at 9 200 EUR/MWh.

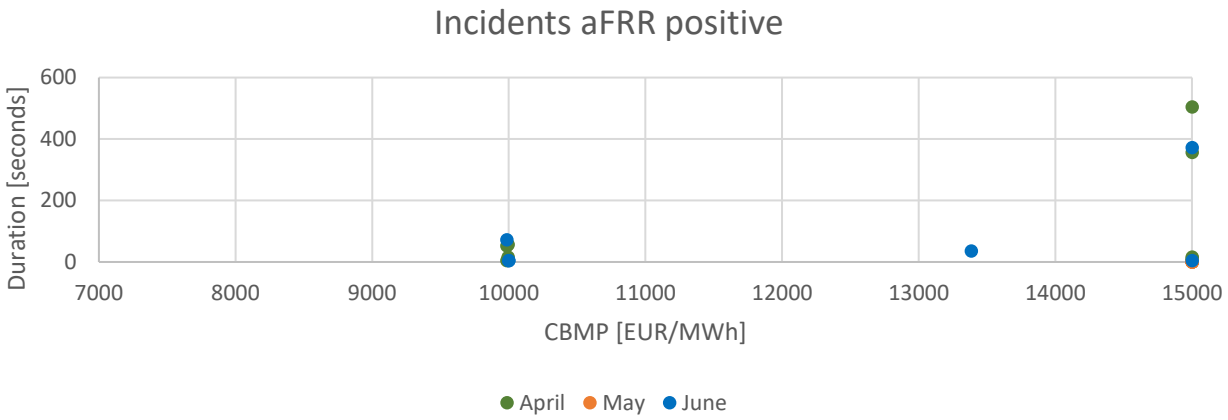

Figure 8: Duration and CBMP of aFRR positive price incidents

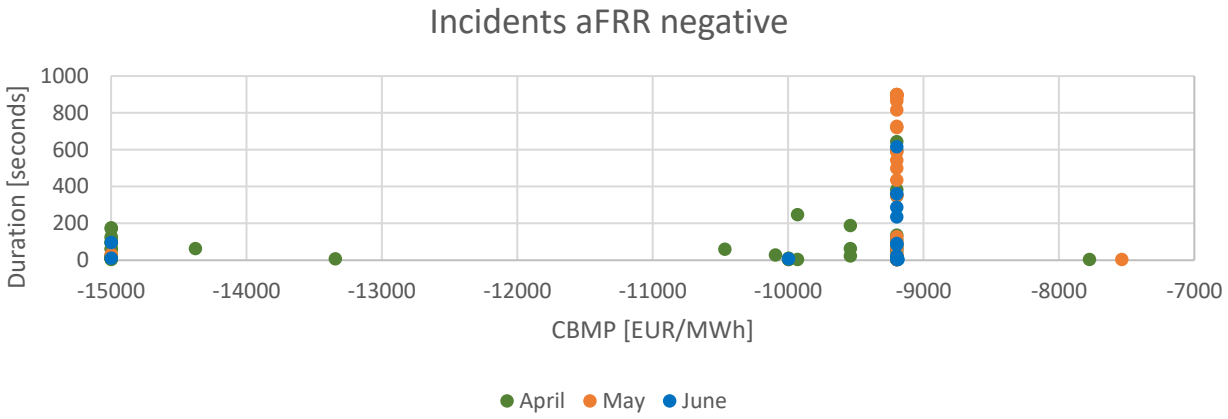

Figure 9: Duration and CBMP of aFRR negative price incidents

4. Overall market concentration level and BSP market shares decreased, yet with pivotal position

The overall market concentration level for the aFRR price incidents decreased in Q2 2023 and follows the trend already observed in the first quarter of 2023. Only during a few incidents, the market concentration is ranked as “high”. When starting the observations in Q3 2022, a large number of incidents came with high market concentration. Nevertheless, the pivotality of BSPs in all incidents remains unchanged (Figure 11). This issue will probably not change with more TSOs joining the platforms as local BSP structure will not change and there will always be moments when local markets are isolated due to non available ATCs or moments when low or no amounts of non-contracted balancing energy bids are submitted.. Looking at the market shares of the largest BSP in the affected uncongested areas shows that in 51 % of all aFRR incidents the largest supplier had a market share of at least 25 % but only during two incidents the largest supplier had a market share of 50 % or more.

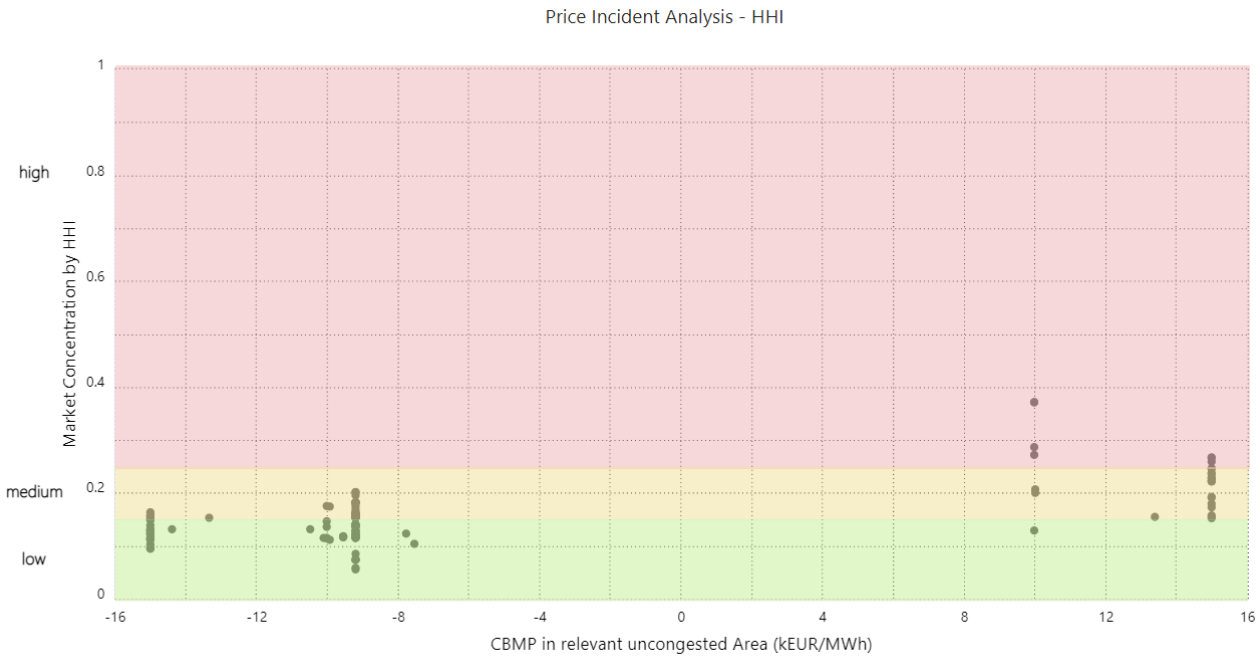

Figure 10: aFRR price incident analysis - HHI

Figure 11: aFRR price incident analysis - RSI

4.2 Analysis of the mFRR pricing incidents

In Q2 2023, only six mFRR incidents occurred, one for scheduled activation in positive direction and the remaining five for scheduled and direct activation in negative direction lasting between 15 and 30 minutes (i.e., one or two MTUs). All incidents occurred when no ATC was available leading to either Germany or Czech Republic forming solely the affected uncongested area (Figure 12). Looking at the market concentration level, it is lower compared to the concentration on the aFRR market but similarly, the largest supplier was pivotal to meet the submitted mFRR demand during all price incidents expect one (Figure 15 and 16). This also means that not sufficient non-contracted bids were available during the price incidents indicating a less attractive market.

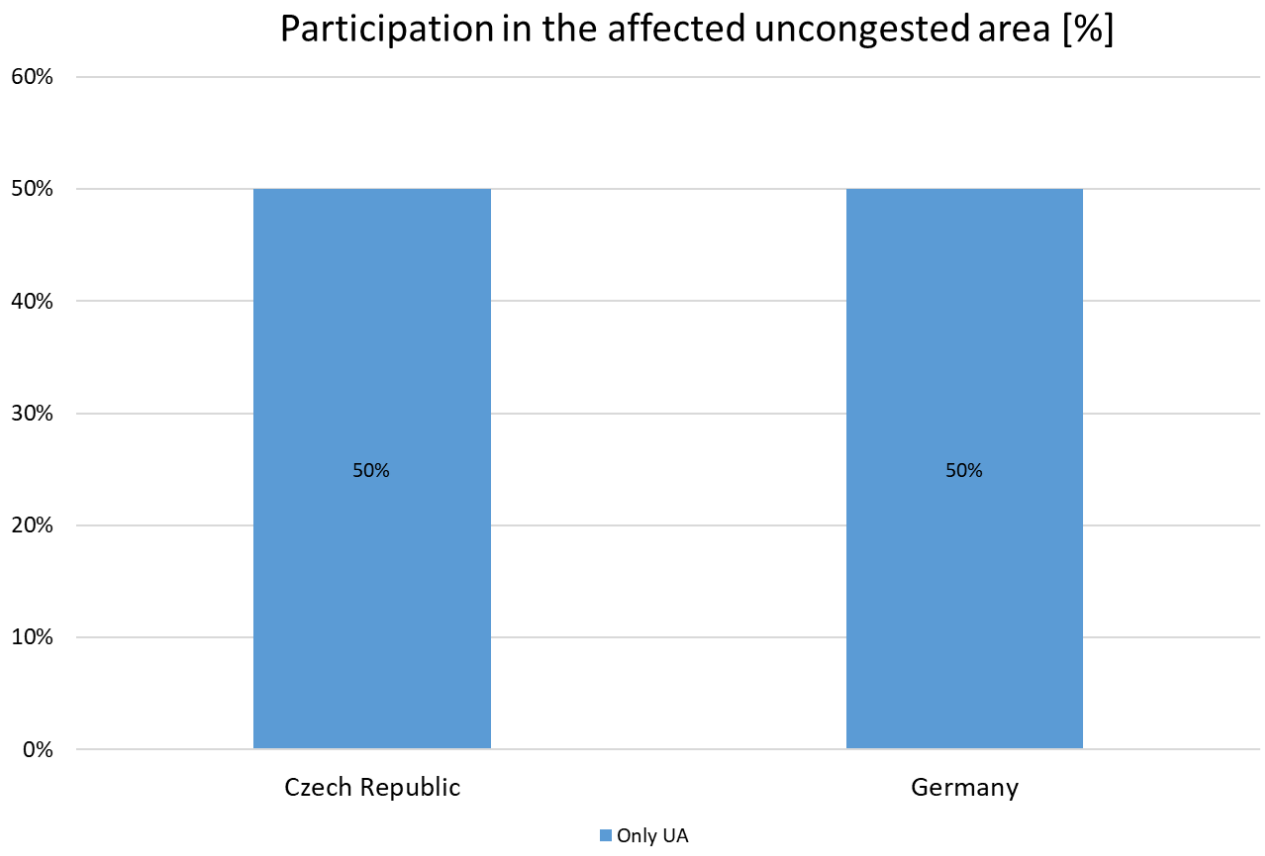

Figure 12: Country participation in the uncongested area affected by a mFRR price incident

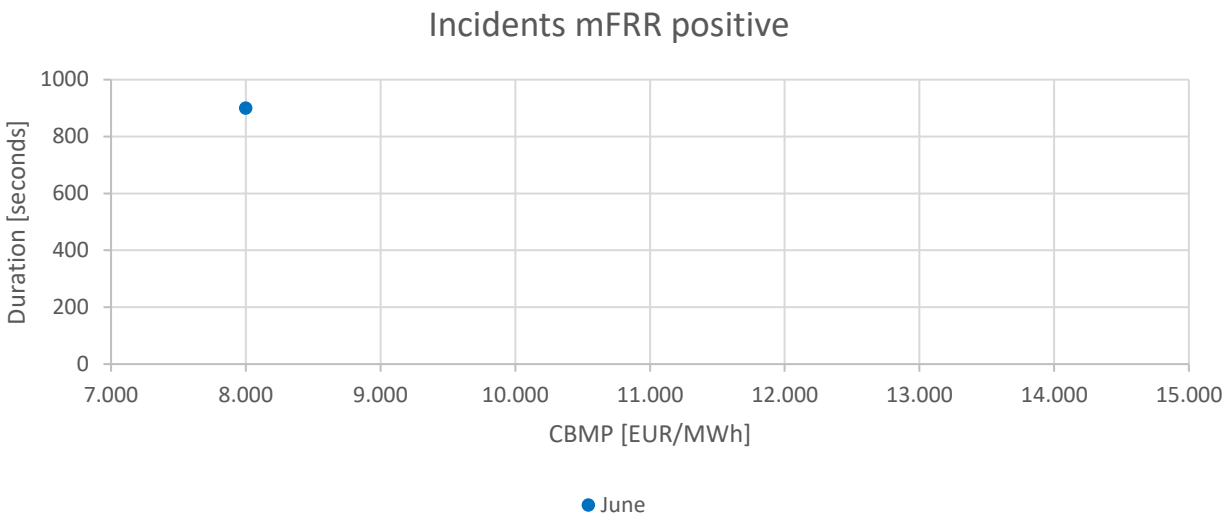

Figure 13: Duration and CBMP of mFRR positive price incidents

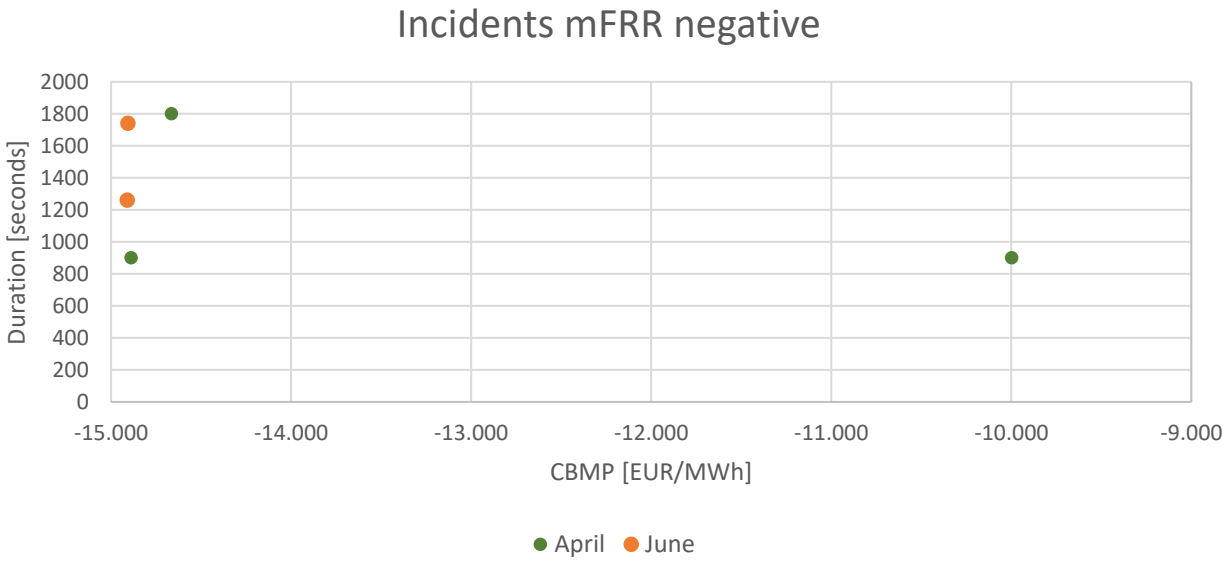

Figure 14: Duration and CBMP of mFRR negative price incidents

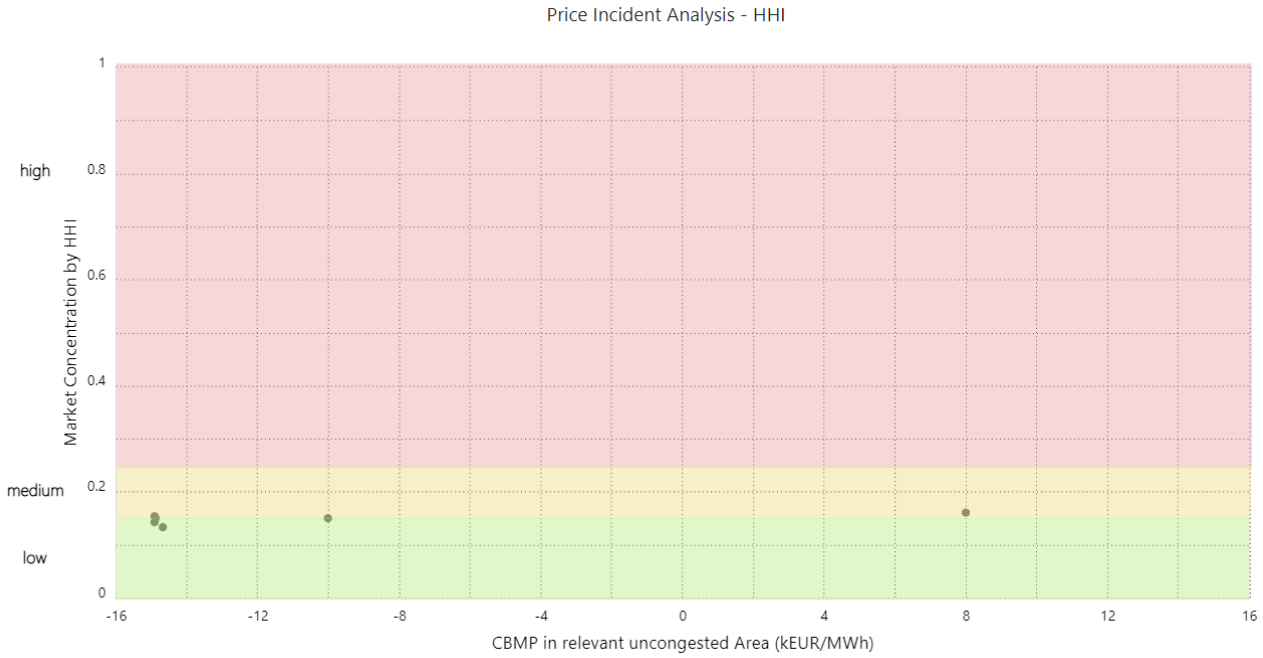

Figure 15: mFRR price incident analysis - HHI

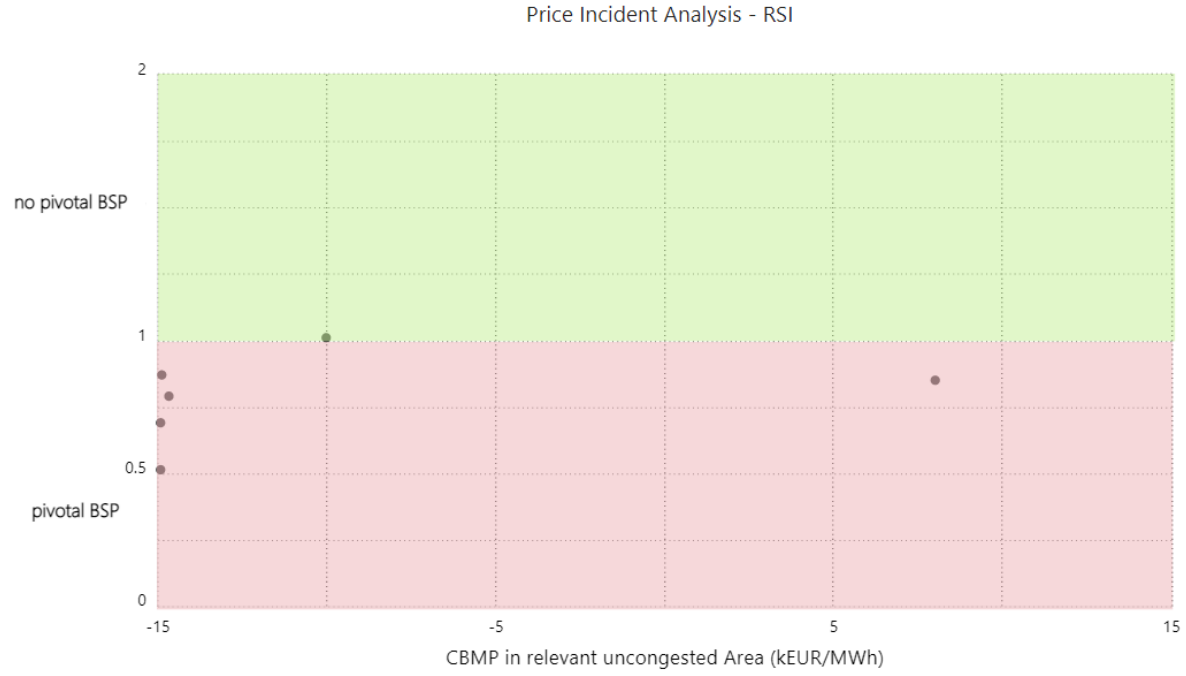

Figure 16: mFRR price incident analysis - RSI

4.3 Analysis of the RR pricing incidents

No RR incidents according to article 9(5) of the amended Balancing Pricing Methodology occurred in Q2 2023.

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Annex – Calculation formulas for the PIs

1. Monthly average values of used and available cross-zonal capacity for the exchange of balancing energy

Definition	Monthly average values per MTU to be calculated for each balancing energy platform per each BZ border in both directions. Each balancing energy platform needs to report four values per BZ border: the CZC initially available per border and per direction and the CZC used per border and per direction.
Legal reference	Article 9(4) of the amended pricing methodology
Time reference	Monthly average values per MTU
Data source	TERRE, MARI, PICASSO The data will be collected directly from the platforms in a ready-for-reporting format.
Calculation	**Available CZC for BZ border$_{ij}$ [MW] (one indicator per direction)** $$= \frac{\sum_{MTU} Volume\ of\ initial\ (import/export)\ CZC\ available\ on\ BZ\ border_{ij}\ for\ RR/mFRR/aFRR}{Market\ Time\ Units\ per\ month}$$ where BZ border$_{ij}$ represents the border of BZ$_i$ and BZ$_j$ of all bidding zones connected to the RR/mFRR/aFRR platform **Used CZC for BZ border$_{ij}$ [MW] (one indicator per direction)** $$= \frac{\sum_{MTU} Volume\ of\ initial\ (import/export)\ CZC\ available\ on\ BZ\ border_{ij}\ for\ RR/mFRR/aFRR}{Market\ Time\ Units\ per\ month}$$ $$- \frac{\sum_{MTU} Volume\ of\ residual\ (import/export)\ CZC\ available\ on\ BZ\ border_{ij}\ for\ RR/mFRR/aFRR}{Market\ Time\ Units\ per\ month}$$ where BZ border$_{ij}$ represents the border of BZ$_i$ and BZ$_j$ of all bidding zones connected to the RR/mFRR/aFRR platform

2. Average percentage of submitted and activated standard balancing energy bids compared the upper (and lower) transitional price limit

Definition	The average percentage of the submitted and selected standard balancing energy bids are calculated on a monthly basis. For each balancing energy platform 20 values are collected, 5 values (50%, 75%, 90%, 95% and 99%) in upward and respectively in downward direction for a) submitted and b) selected balancing energy bids.
Legal reference	Article 9(4) of the amended pricing methodology
Time reference	Monthly average values per MTU
Data source	TERRE, MARI, PICASSO The data will be collected directly from the platforms in a ready-for-reporting format.
Calculation	**Submitted upward balancing energy bids with prices higher than x% of the upper price limit [%]** $= \frac{\sum_{MTU} volume\ of\ submitted\ upward\ RR/mFRR/aFRR\ bids_j \text{ higher than x\%}}{\sum_{MTU} volume\ of\ all\ submitted\ upward\ RR/mFRR/aFRR\ bids}$ where $bids_j$ represent all submitted upward RR/mFRR/aFRR bids with offered prices higher than p_j = 50%, 75%, 90%, 95% and 99% of the upper transitional price limit **Submitted downward balancing energy bids with prices lower than x% of the lower price limit [%]** $= \frac{\sum_{MTU} volume\ of\ submitted\ downward\ RR/mFRR/aFRR\ bids_j \text{ lower than x\%}}{\sum_{MTU} volume\ of\ all\ submitted\ downward\ RR/mFRR/aFRR\ bids}$ where $bids_j$ represents all submitted downward RR/mFRR/aFRR bids with offered prices lower than p_j = 50%, 75%, 90%, 95% and 99% of the lower transitional price limit **Upward balancing energy with prices higher than x% of the upper price limit [%]** $= \frac{\sum_{MTU} volume\ of\ (activated)\ upward\ balancing\ energy\ RR/mFRR/aFRR\ with\ prices\ higher\ than\ x\%}{\sum_{MTU} volume\ of\ upward\ balancing\ energy\ RR/mFRR/aFRR}$ where x% refers to 50%, 75%, 90%, 95% and 99% of the upper transitional price limit **Downward balancing energy with prices lower than x% of the lower price limit [%]** $= \frac{\sum_{MTU} volume\ of\ (activated)\ downward\ balancing\ energy\ RR/mFRR/aFRR\ with\ prices\ lower\ than\ x\%}{\sum_{MTU} volume\ of\ downward\ balancing\ energy\ RR/mFRR/aFRR}$ where x% refers to 50%, 75%, 90%, 95% and 99% of the lower transitional price limit

3. Volume weighted average price of the last and most expensive balancing energy bids

Definition	The VWAP of the last 5% of the submitted bids per platform, per direction and per participating TSO is calculated on a monthly basis. Each balancing platform needs to report two values per connected TSO, one for upward and one for downward direction.
Legal reference	Article 9(4) of the amended pricing methodology
Time reference	Monthly
Data source	TERRE, MARI, PICASSO The data will be collected directly from the platforms in a ready-for-reporting format.
Calculation	**VWAP of the last most expensive 5% of the upward balancing energy bids submitted by TSO_i [EUR/MWh]** $= \frac{\sum_j volume\ of\ most\ expensive\ 5\%\ submitted\ RR/mFRR/aFRR\ bid_j\ x\ price\ of\ submitted\ RR/mFRR/aFRR\ bid_j}{\sum_j volume\ of\ most\ expensive\ 5\%\ submitted\ RR/mFRR/aFRR\ bid_j}$ where i=1,2,… represents the TSOs connected to the RR/mFRR/aFRR platform and where j represents the last 5% of submitted upward balancing energy bids by TSO_i **VWAP of the last 5% of the downward balancing energy bids submitted by TSO_i [EUR/MWh]** $= \frac{\sum_j volume\ of\ most\ expensive\ 5\%\ submitted\ RR/mFRR/aFRR\ bid_j\ x\ price\ of\ submitted\ RR/mFRR/aFRR\ bid_j}{\sum_j volume\ of\ most\ expensive\ 5\%\ submitted\ RR/mFRR/aFRR\ bid_j}$ where i=1,2,… represents the TSOs connected to the RR/mFRR/aFRR platform and where j represents the last 5% of submitted downward balancing energy bids by TSO_i