European Network of
Transmission System Operators
for Electricity

Quarterly Report Q4/2022 according to article 9(4) of the common methodology for the pricing of balancing energy and cross-border capacity

24 February 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 October to 31 December 2022 for PICASSO and TERRE as well as for MARI the period from 5 October (go-live date of MARI) to 31 December 2022in 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/RR exchange 2. CZC used per BZ border and direction for the aFRR/RR exchange

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

	October 2022		November 2022		December 2022	
	Available CZC	Used CZC	Available CZC	Used CZC	Available CZC	Used CZC
DE -> CZ	150	8	82	4	446	18
CZ -> DE	349	32	797	32	349	28
DE -> AT	255	39	165	40	320	48
AT -> DE	1 751	38	2 655	33	1 454	34
CZ -> AT	128	13	89	7	84	9
AT -> CZ	758	31	1 284	39	1 545	39

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

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

	October 2022 (starting from 5 October)[5]		November 2022		December 2022	
	Available CZC	Used CZC	Available CZC	Used CZC	Available CZC	Used CZC
DE -> CZ	112	0	88	0	449	1
CZ -> DE	714	0	797	0	348	0

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

[5] Please note that only values for the time after MARI go-live are included.

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

	October 2022		November 2022		December 2022	
	Available CZC	Used CZC	Available CZC	Used CZC	Available CZC	Used CZC
ES -> FR	355	161	473	237	488	143
ES -> PT	2 128	232	3 472	214	2 316	179
FR -> ES	466	222	382	193	341	142
FR -> CH	1 564	90	4 023	283	3 084	225
FR -> IT	845	100	4 272	186	3 617	163
CH -> FR	3 099	141	938	97	2 452	113
CH -> IT	310	84	4 454	84	3 518	119
IT -> FR	3 869	117	906	115	2 205	123
IT -> CH	3 905	67	1 151	116	2 493	116
PT -> ES	4 051	300	2 844	239	4 206	280

Table 3: TERRE – Monthly average values of 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%**
Ocotber 2022	10.2%	7.4%	6.2%	5.9%	5.7%	3.2%	2.0%	1.8%	1.8%	1.7%
November 2022	6.8%	4.2%	3.6%	3.4%	3.2%	4.2%	3.0%	2.7%	2.6%	2.5%
December 2022	13.4%	9.3%	7.9%	7.5%	7.2%	6.7%	5.5%	5.0%	4.8%	4.7%

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%**
Ocotber 2022	0.085%	0.070%	0.069%	0.068%	0.067%	0.056%	0.022%	0.016%	0.014%	0.013%
November 2022	0.015%	0.008%	0.008%	0.008%	0.008%	0.005%	0.003%	0.003%	0.003%	0.002%
Dezember 2022	0.004%	0.001%	0.001%	0.001%	-	0.008%	0.004%	0.004%	0.004%	0.004%

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%**
Ocotber 2022	25.03%	14.46%	10.87%	10.23%	8.06%	9.04%	3.07%	1.24%	1.02%	0.82%
November 2022	25.28%	14.32%	12.32%	11.90%	9.54%	7.20%	2.16%	0.88%	0.81%	0.57%
December 2022	26.05%	15.99%	14.24%	14.14%	12.48%	17.05%	10.77%	8.56%	8.06%	7.18%

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%**
Ocotber 2022	-	-	-	-	-	-	-	-	-	-
November 2022	-	-	-	-	-	-	-	-	-	-
December 2022	-	-	-	-	-	18.85%	11.48%	-	-	-

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%**
October 2022	2.66%	1.34%	0.85%	0.76%	0.52%	0.80%	0.69%	0.04%	0.04%	0.04%
November 2022	1.32%	0.80%	0.36%	0.28%	0.11%	1.10%	0.80%	0.18%	0.18%	0.07%
December 2022	0.94%	0.64%	0.29%	0.26%	0.09%	0.87%	0.64%	0.29%	0.29%	0.29%

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%**
Ocotber 2022	-	-	-	-	-	-	-	-	-	-
November 2022	-	-	-	-	-	-	-	-	-	-
December 2022	-	-	-	-	-	-	-	-	-	-

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

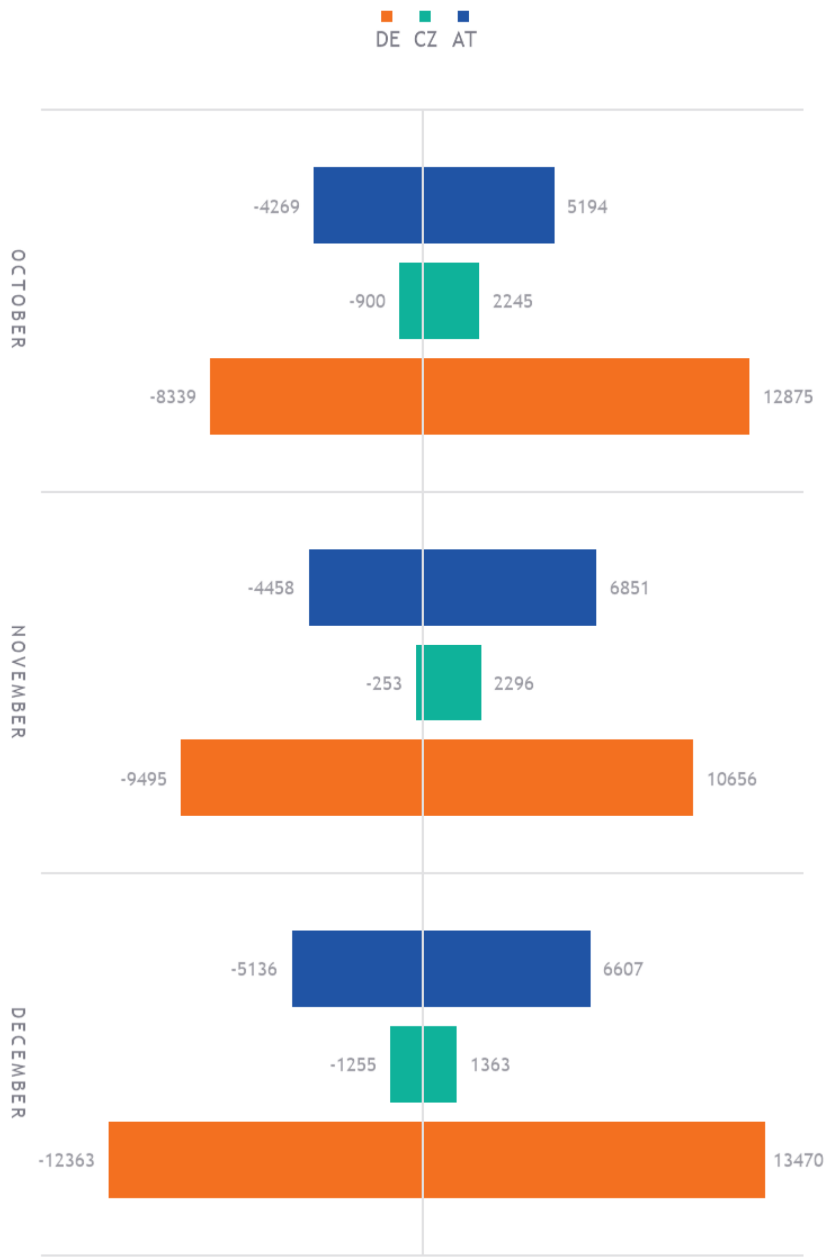

Figure 1: PICASSO - VWAP of the 5% most expensive aFRR bids submitted [EUR/MWh] per country

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

Figure 2: 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

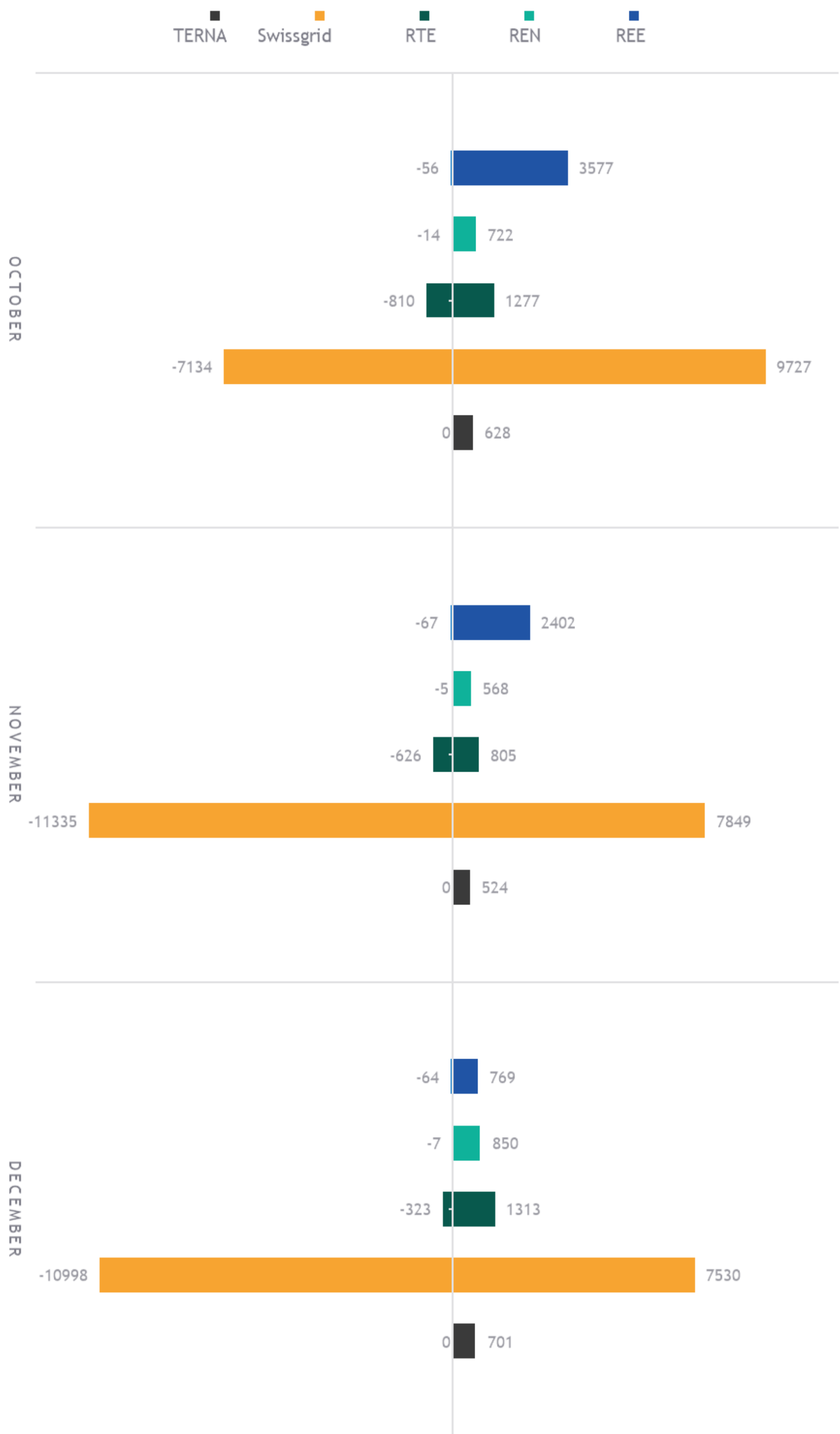

Figure 3: TERRE - VWAP of the 5% most expensive RR bids submitted [EUR/MWh] per country

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 upper pr lower transitional price limit. Such a price incident is triggered whenever the threshold of 50% of the CBMP 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 choose 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 108 price incidents occurred between 1 October and 31 December 2022 in the aFRR market. Compared to the incidents reported for the first quarter of operation (Q3 2022), several observations can be made.

In total 108 price incidents occurred between 1 October and 31 December 2022 in the aFRR market. Compared to the incidents reported for the first quarter of operation (Q3 2022), several observations can be made.

1. Majority of incidents occurred in negative direction

While in Q3 2022 the incidents have been almost evenly distributed in both directions, there was a clear shift of incidents that occurred in negative direction in Q4. Only 28 out of the 108 incidents took place in positive direction.

2. Mostly Germany and Austria were part of the affected uncongested area

Like for the incidents in Q3, Czech Republic was only in one incident affected solely by a CBMP beyond the price reporting threshold. In all other incidents, either Austria, Germany, both countries together or all three participating countries including Czech Republic formed the affected uncongested area (Figure 7). One of the main causes for the expensive aFRR CBMP are the “hockey-stick” shaped MOL in Germany and Austria. The “hockey-stick” shape results from BSPs bidding significantly more expensive bids from a certain position in the MOL compared to the front part of the MOL. This results in an expensive CBMP, if sufficiently many bidders submit expensive balancing energy expensive bids at the end of the MOL and a high demand for balancing energy realizes the activation of these balancing energy bids. The analysis of the incidents shows that the CBMP often jumps significantly if demand is high and passes a certain threshold (tipping point of hockey stick).

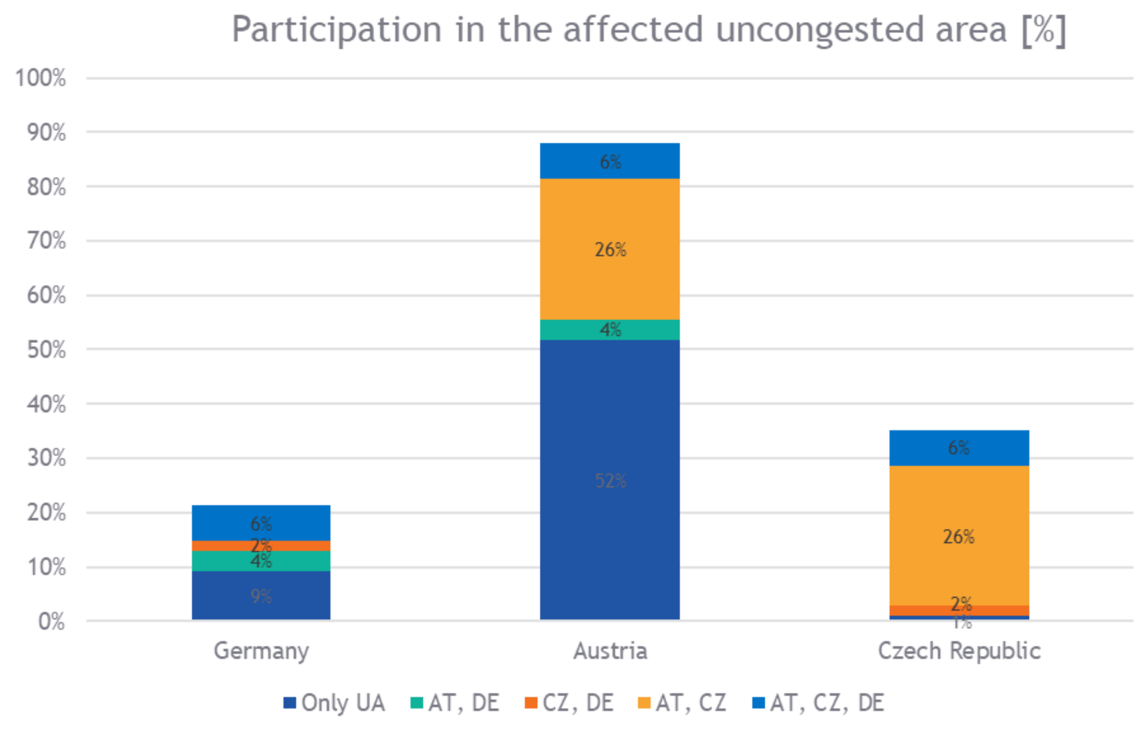

Figure 4: Country participation in the uncongested area affected by an aFRR price incident

3. Incidents are largely triggered at a CBMP of +/- 10 000 EUR/MWh

In market theory[6], BSPs that participate with several power generating modules in the market, additionally allowing for the submission of small incremental bids, have an incentive to exaggerate in their bids the costs of their expensive power generating modules to increase the marginal price being paid for all their activated bids. This particularly applies to powerful BSPs with a large market share. In addition, regular repetition of the balancing energy auctions under similar conditions and short validity periods of bids (15 minutes for PICASSO) are factors that may incentivize tacit collusion: submission of high bids in order to coordinate the regularly participating BSPs on high bids[7]. Figures 8 and 9 show that majority of incidents were triggered at +/- 10 000 EUR/MWh. Having this price setting behavior may be an indication that there are other bidding strategies than bidding the costs of energy generation.

[6] *Please see the External Study attached to the submission of the pricing methodology amendment for further information: https://consultations.entsoe.eu/markets/proposal-for-amendment-of-pricing-methodology/supporting_documents/210602_Report%20on%20Justification%20of%20Max%20Min%20BE%20Prices.pdf*

[7] *Berninghaus, S.K., and Ehrhart, K.-M. (1998): Time Horizon and Equilibrium Selection in Tacit Coordination Games: Experimental Results. Journal of Economic Behavior and Organization 37(2), 231–248.; Fudenberg, D., and Maskin, E. (1986): The Folk Theorem in Repeated Games with Discounting or Incomplete Information, Econometrica 54(3), 533–554.; van Damme, E. (1991): Stability and Perfection of Nash Equilibria, 2nd edition, Springer.*

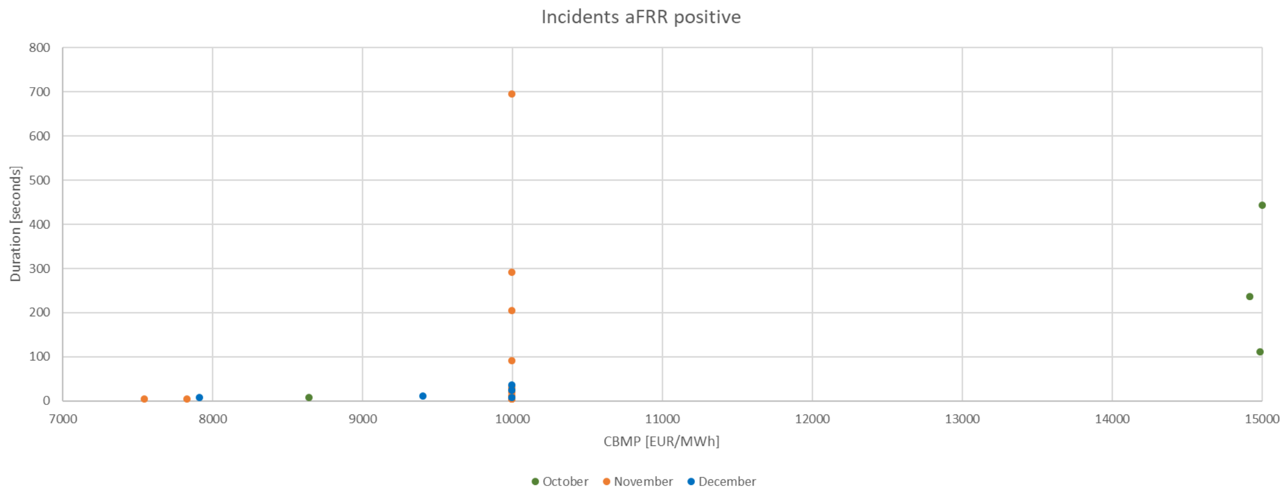

Figure 5: Duration and CBMP of aFRR positive price incidents

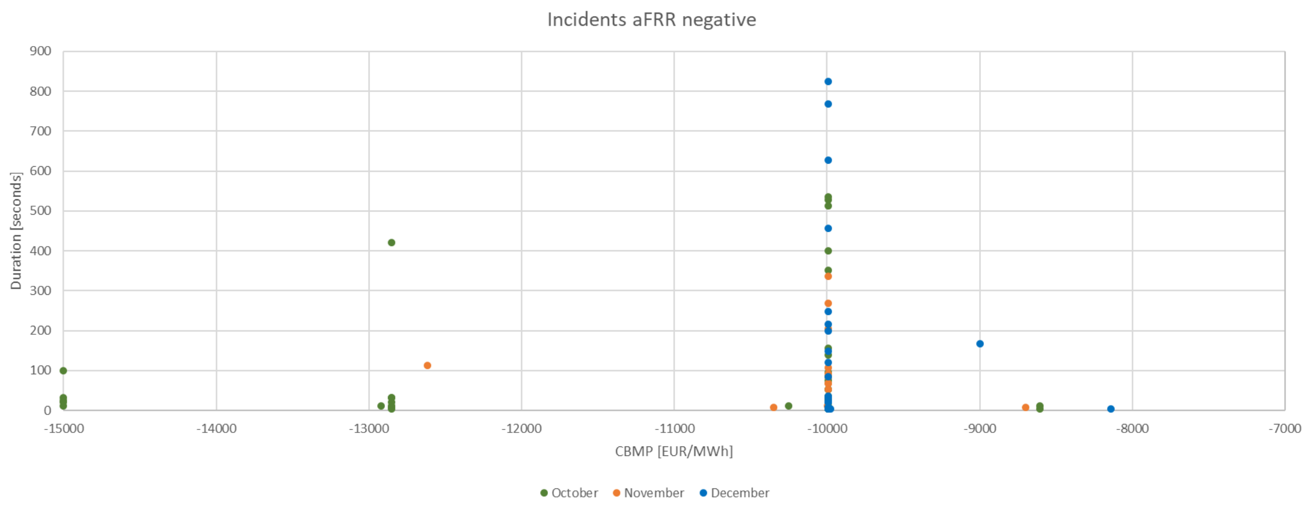

Figure 6: Duration and CBMP of aFRR negative price incidents

4. Overall market concentration levels decreased, yet with pivotal position of BSPs

Figure 10 shows that the overall market concentration levels in Q4 decreased slightly compared to the price incidents in Q3. Looking at the market shares of the largest BSP in the affected uncongested areas during the price incidents shows that in 57 percent of all aFRR incidents the largest supplier had a market share of at least 25 percent but only in 9 incidents the largest supplier had a market share of 50 percent or more. In Q3 this was the case for 40 percent of all incidents. Despite the observed decrease in market concentration, there was still a pivotal BSP in each price incident that occurred (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 low ATCs.

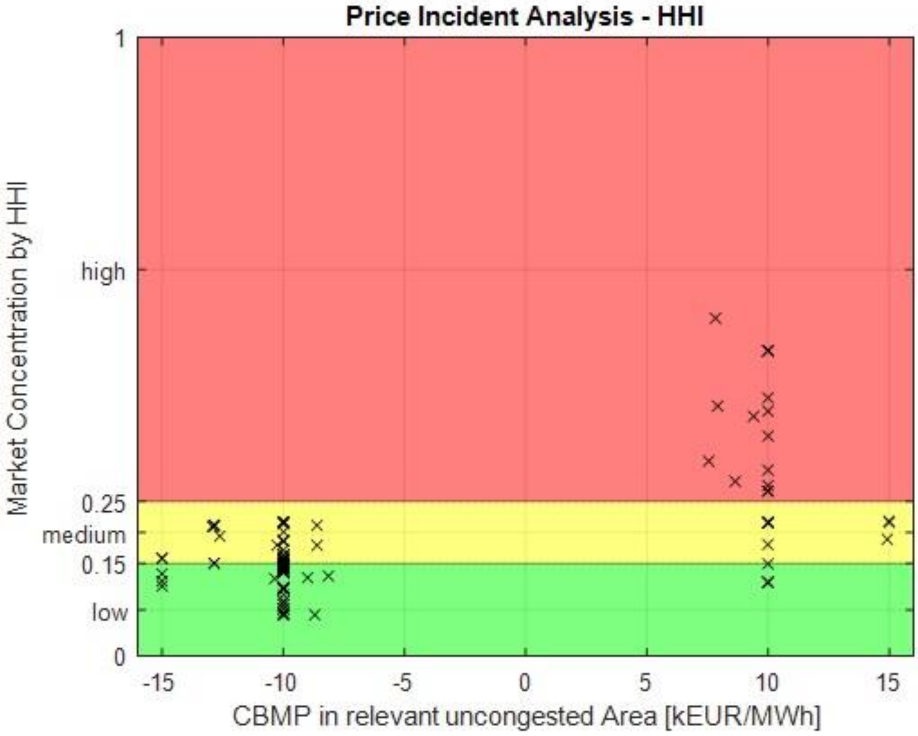

Figure 7: aFRR price incident analysis - HHI

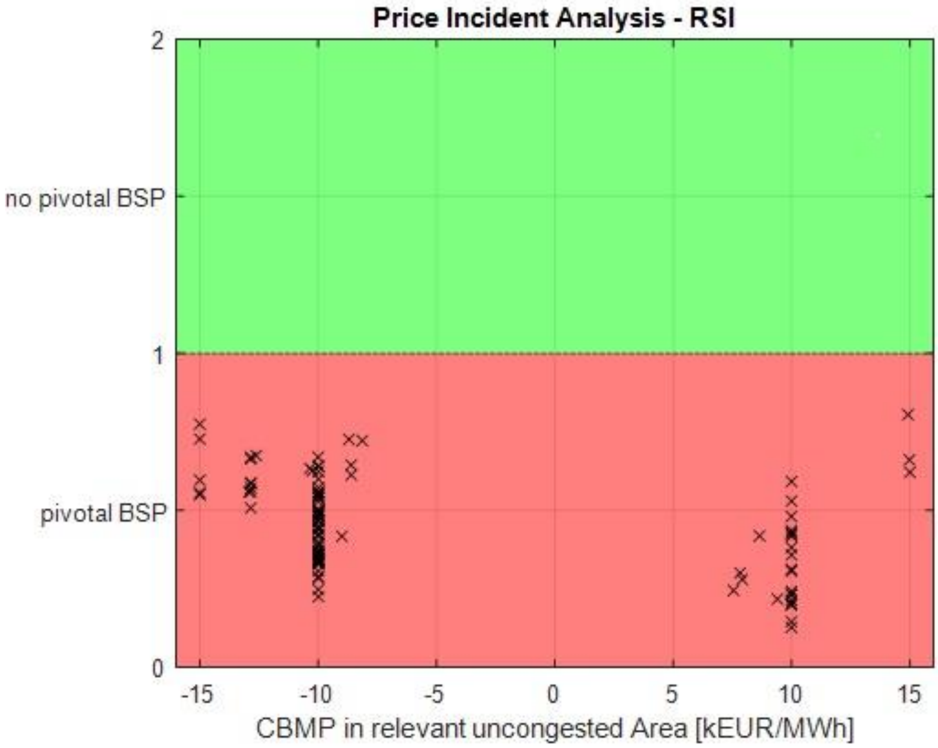

Figure 8: aFRR price incident analysis - RSI

4.2 Analysis of the mFRR pricing incidents

In Q4 2022, only two mFRR incidents occurred on 24 December. The two incidents affected both connected countries, Czech Republic and Germany, and were triggered by a direct activation in negative direction. Direct activations are required to perform further activations when imbalances occur between two scheduled activations. Direct activations allow to activate mFRR bids at any point in time when an unexpected imbalance occurs and last until the end of the next MTU. This definition of direct activations allows an incident to impact two quarter hours.

At 6 pm on 24 December, Germany sent a high demand to the MARI platform. This caused the activation of bids at the end of the CMOL with high prices triggering the price incident. The incident lasted 30 minutes.

At 7:49 pm, Germany submitted a demand of 400 MW to MARI following a direct activation of 300 MW in the previous quarter hour. The activation time of direct activations until the end of the next quarter hour (i.e., the price incident quarter hour) led to an increased overall demand to be satisfied. Therefore, bids at the end of the CMOL had to be activated triggering an incident with a duration of 26 minutes.

4.3 Analysis of the RR pricing incidents

No RR incidents according to article 9(5) of the amended Balancing Pricing Methodology occurred in Q4 2022.

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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