
Explanatory Document to the proposal of all Transmission System Operators performing the reserve replacement for the implementation framework for the exchange of balancing energy from Replacement Reserves in accordance with Article 19 of Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing

18th of June

DISCLAIMER

This document is submitted by RR transmission system operators (TSOs) to the RR NRAs for information purposes only accompanying the RR TSOs' proposal for the implementation framework for the exchange of balancing energy from Replacement Reserves in accordance with Article 19 of Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing.

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1. Introduction

This document gives background information and rationale for the RR TSOs proposal for the implementation framework for the exchange of balancing energy from Replacement Reserves (this proposal is hereafter referred to as the “RR Implementation Framework” or “RRIF”), required by Article 19 (1) of Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing (hereafter referred to as “EBGL”).

2. Explanation of the TERRE project and the governance structure

TERRE project is the implementation project for the RR-Platform with the scope of implementing a multi-TSO coordinated exchange of RR balancing energy to comply with the EBGL. The model for the Exchange of the Balancing Energy considered in this project will be the TSO-TSO model. The main objective of the TERRE project is to establish and operate an RR-platform capable of gathering all the RR standard products from TSOs' local balancing markets and providing an optimized allocation of RR, covering the TSOs' RR balancing energy needs. The TERRE project started with a bottom-up approach. More specifically, the project started with harmonization of main principles instead of a full harmonization from the beginning¹.

The RR TSOs which currently participate to the TERRE project and the RRIF are: National Grid, Swissgrid, REE, REN, MAVIR, TERNA, Transelectrica, RTE, CEPS and PSE. ESO also joined TERRE project in January 2018. The TERRE project remains open for new participants who would like to join the project as observer or as member.

The list of RR TSOs will be updated once a new Member will join the TERRE project or the RR-Platform.

¹ The project TERRE with a reduced TSOs members scope (National Grid, RTE, REE, REN, TERNA and Swissgrid) conducted two European public consultation in 2016 and 2017.

The first consultation phase (2016) addressed mainly the TSO-TSO principles and showed the potential benefit of a common RR market.

Link: https://consultations.entsoe.eu/markets/terre/supporting_documents/20160307_TERRE_Consultation_FV.pdf

The second consultation phase (2017) clarified the common harmonized framework of TSO-BSP relations for the RR market.

Link: https://consultations.entsoe.eu/markets/public-consultation-document-for-the-design-of-the/supporting_documents/Consultation%20paper%20on%20TERRE%20design%20and%20RR%20market%20harmonization.pdf

Following each public consultation phase, two approval packages which contained the results of the stakeholders' feedbacks assessment were submitted to the related NRAs.

The NRAs expressed jointly their support to the TERRE project by publishing two “common opinion papers”.

3. The roadmap and timeline for the implementation of the RR-Platform

The public consultation on the RRIF took place between 21st of February and 4th of April 2018, and lasted for six weeks. The aim of the public consultation was to allow European stakeholders to provide their feedback on the RRIF to the TSOs. The TSOs considered the stakeholders' opinion and implemented last amendments before the final submission of the RRIF to the NRAs for approval.

The submission of the RRIF to the NRAs will take place at the latest on 18th of June 2018, i.e. six months after entry into force of the EBGL. The RRIF package will consist of the RRIF document, the stakeholders' feedback, the TSOs assessment on the stakeholders' feedback and an this explanatory document elaborating on the main technical RR process. The approval period by NRAs will start once the RRIF package has been submitted by the TSOs.

The go-live of the RR-platform is foreseen to take place one year after the approval of the RRIF, as required by the EBGL.

4. High-level design of the RR-Platform

The objective of the RR-Platform is to support the exchange of RR standard products between RR TSOs that have at least one neighbouring RR TSO. The RR-Platform will gather all the Bids from the TSOs' local balancing markets and provide an optimised allocation of RR in order to meet the TSOs' balancing energy needs.

The TSO-TSO process is the following:

- The TSOs receive Bids from the BSPs in their national market balance areas and systems.
- The Bids are anonymized and forwarded to the RR-Platform.
- TSOs applying a central dispatching model, pursuant to Article 27 of the EBGL, will convert integrated scheduling bids received from the BSPs into standard RR standard products and then submit the RR standard product to the RR-Platform.
- TSOs also communicate their RR balancing energy needs to the platform, as well as the available cross-zonal capacities remaining after the intraday market.
- The RR-Platform executes the AOF (Activation Optimisation Function described in section 7) that optimises the clearing of the TSOs' RR balancing energy needs against the BSPs' Bids.
- The RR-Platform communicates back to the TSOs the accepted Bids, the satisfied RR balancing energy needs and the prices. Based upon this allocation of the RR standard product, the platform calculates the commercial flows between the bidding zones. The resulting cross zonal schedules and updated cross-zonal capacities are sent to the TSOs and possibly also to verification platforms.
- Data that must be published are sent to the central transparency platform according to the transparency 543/2013 regulation and article 12 of the EBGL.
- Finally, the information required to settle expenditure and revenue between TSOs, i.e. the financial value of the energy flows across bidding zones, is sent to TSO-TSO settlement function responsible for the financial accounting between TSOs (TSO-TSO settlement function described in section 10).

5. The format possibilities of the Bids

The following bid formats will be submitted and processed by LIBRA:

- Fully divisible bids

- Divisible bids
- Indivisible bids
- Linked bids in time
- Exclusive bids in volume
- Exclusive bids in time
- Multi-part bids

5.1. Fully divisible Bid

A fully divisible bid is a balancing energy bid that consists of a single quantity and a single price. Its delivery period is 15 minutes, and it has no minimum quantity. One example of a fully divisible bid with delivery period is presented in Figure 1.

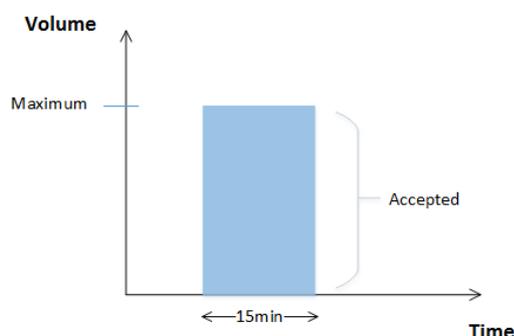


Figure 1: Fully divisible bid

If the bid is accepted, the accepted quantity will be less or equal to the offered quantity and greater than zero. If the bid is rejected, the accepted volume will be zero. The fully divisible bid characteristics are defined in the Table 1.

Table 1: Fully divisible bid characteristics

Characteristics	Allowed values
Direction	Upward or downward
Max Volume	Between 0 and IT limit
Min volume	0
Price	Between price cap and floor
Delivery period	[H,H+15] OR [H+15,H+30] OR [H+30,H+45] OR [H+45,H+60]

5.2. Divisible Bid

A divisible bid is a balancing energy bid that consists of a single quantity and a single price. Its delivery period is 15 minutes, and has a minimum quantity greater than zero. An example of a divisible bid is illustrated in Figure 2.

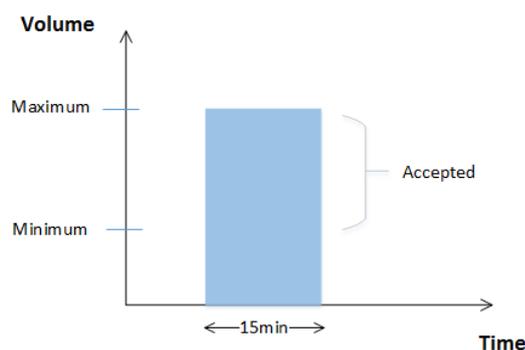


Figure 2: Divisible bid

If the bid is accepted, the accepted volume will be less or equal to the maximum volume and greater or equal to the minimum quantity. If the bid is rejected, the accepted volume will be zero. The divisible bid characteristics are defined in the Table 2.

Table 2: Divisible bid characteristics

Characteristics	Allowed values
Direction	Upward or downward
Max Volume	Between 0 and IT limit
Min volume	Different from 0, lower than max volume
Price	Between price cap and floor
Delivery period	[H,H+15] OR [H+15,H+30] OR [H+30,H+45] OR [H+45,H+60]

5.3. Indivisible bid

An indivisible bid is a balancing energy bid that consists of a single quantity and a single price. They are also referred to as block bids. Its delivery period is 15 minutes, and has a minimum quantity equal to its maximum quantity. An example of an indivisible bid is presented in Figure 3. Either the whole indivisible bid or nothing is accepted

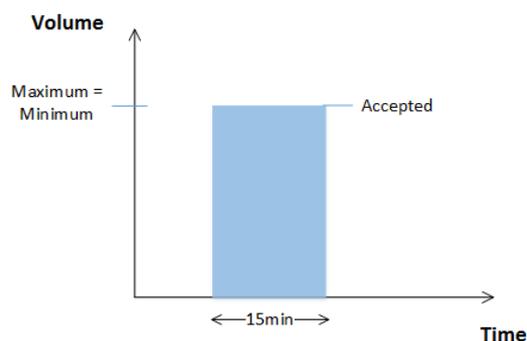


Figure 3: Indivisible bid

The indivisible bid characteristics are defined in the Table 3.

Table 3: Indivisible bid characteristics

Characteristics	Allowed values
Direction	Upward or downward
Max Volume	Between 0 and IT limit
Min volume	Equal to max quantity
Price	Between price cap and floor
Delivery period	[H,H+15] OR [H+15,H+30] OR [H+30,H+45] OR [H+45,H+60]

5.4. Linked bids in time

The linked bids in time are balancing energy bids for which the same acceptance ratio α will be accepted. The acceptance ratio α represents the accepted quantity of a bid divided by the maximum offered volume. Therefore, this can be expressed mathematically as follows:

$$\alpha_i = \frac{q_i}{Q_i^{max}}$$

Where:

α_i : acceptance ratio of the bid i

q_i : accepted volume of the bid i

Q_i^{max} : maximum volume of the bid i

The linked bids in time can be either fully divisible or divisible or indivisible bids and they must correspond to different single time steps. In addition, they can have different volumes and/or prices. An example of four linked bids in time is presented in Figure 4.

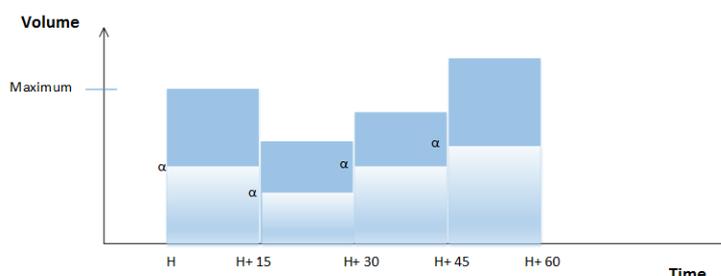


Figure 4: Linked bids in time

In this example, the same percentage of quantity is activated for each bid relatively to the maximum quantities, i.e. the same acceptance ratio α is applied: $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4$. The minimum quantity is just a constraint, thus only the most constraining one is relevant and used by the algorithm. BSPs must submit linked bids in time:

- Either as a curve: in this case, the associated linked bids in time will have a single direction, i.e. upwards or downwards, as they correspond to a single bid.

Bid ID	Direction	Max vol.	Min vol.	Price	Delivery Period	Linked bid ID
546454	Upward or downward	Q_max1	Q_min1	P1	[H,H+15]	n/a
		Q_max2	Q_min2	P2	[H+15,H+30]	
		Q_max3	Q_min3	P3	[H+30,H+45]	
		Q_max4	Q_min4	P4	[H+45,H+60]	

Note that a discontinuous curve is also allowed, e.g. Q_max2 can be equal to zero, and Q_max1, Q_max3 and Q_max4 greater than zero.

- Or with explicit links: in this case, similarly to the linked bids in volume described above, several bids will be defined by the BSP and will be linked with an explicit link in time.

Bid ID	Direction	Max vol.	Min vol.	Price	Delivery Period	Linked bid ID
546454	Upward or downward	Q_max1	Q_min1	P1	[H,H+15]	1
254542	Upward or downward	Q_max2	Q_min2	P2	[H+15,H+30]	1
353254	Upward or downward	Q_max3	Q_min3	P3	[H+30,H+45]	1
254547	Upward or downward	Q_max4	Q_min4	P4	[H+45,H+60]	1

5.5. Exclusive bid either in time or in volume

Exclusive bids are balancing energy bids that satisfy the following condition: only one (or none) of the exclusive bids can be activated; hence, the activation of a bid belonging to a set of exclusive bids excludes the activation of the other bids belonging to the same set. Exclusive bids can either be exclusive in volume or in time. TSOs will define limits regarding the number of the exclusive bids that a BSP can offer to each TERRE clearing, in order to minimize the impact on the performance of the algorithm.

5.5.1. Exclusive bid in volume

The exclusive bids in volume can be either fully divisible or divisible or indivisible bids or linked bids in time submitted as a curve, and they can have different directions, i.e. upwards and/or downwards. These bids can have different volumes and/or prices, however they cannot be in parallel exclusive in time with other bids. An example with two curves exclusive in volume is presented in Figure 5. Only one of the two curves can be accepted. For the curve which will be accepted, the same acceptance ratio will be applied.

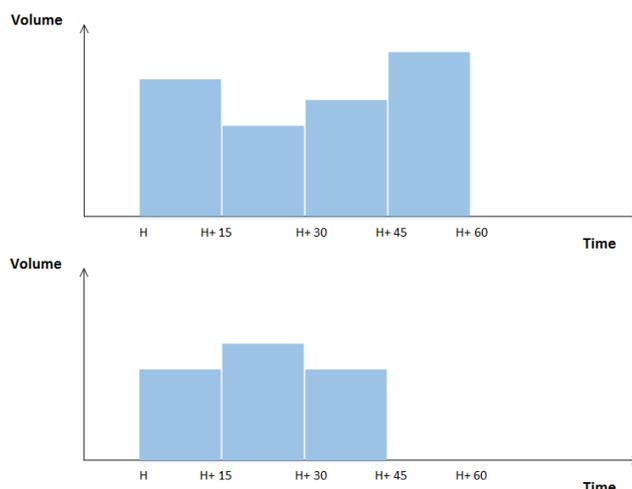


Figure 5: Exclusive bids: example with curves

5.5.2. Exclusive bid in time

The exclusive bids in time can be either fully divisible or divisible or indivisible bids, and they can have different directions, i.e. upwards and/or downwards. These bids can have different volumes and/or prices, however they cannot be in parallel exclusive in volume or linked either in volume or in time with other bids. An example of 4 exclusive bids is presented in Figure 6.



Figure 6: Exclusive bids in time

5.6. Multi-part bid

A multi-part bid is a balancing energy bid that has variable prices for variable quantities as illustrated in Figure 8. For each multi-part bid, a starting time and an ending time has to be defined, in order to indicate the delivery period. Multi-part bids allow BSPs to internally model their fixed costs, e.g. start-up costs. In addition, similarly to the exclusive bids, they allow BSPs which bid per portfolio to depict their costs more accurately.

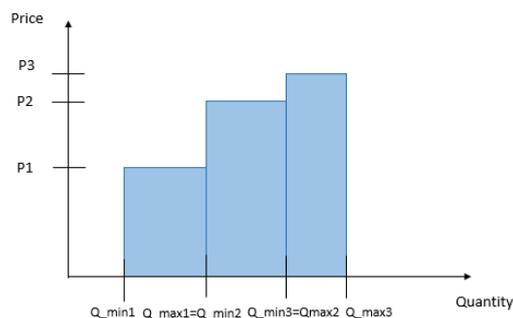


Figure 7: Multi-part bid for a specified delivery period

A multi-part bid can be fully divisible, divisible or indivisible, and has a single direction. The price curve can only be increasing. Note that it is not possible for a multi-part bid to be linked or exclusive either in time or in volume with other bids. Alternatively, it is possible for BSPs to model and submit their multipart bids as exclusive bids.

Note that some TSOs may not allow their BSPs to offer all Bids formats at the first stage of the operation of the RR-Platform, as their local IT systems may not be ready to process all types of Bids. However, to ensure fair competition and non-discriminatory conditions, all BSPs will be allowed to offer all Bids formats at a later stage.

6. TSO balancing energy need

The RRIF presents the harmonised definition of the TSO balancing energy need in Article 11. This section will explain the concept of TSO balancing energy need elasticity as well as the use of a tolerance band.

Elastic RR balancing energy need

RR TSOs have the obligation to manage their systems in a cost-efficient way. Therefore, some RR TSOs they aim to use elastic balancing energy needs. They can hence submit a price for their need which indicates the maximum price they are willing to pay in order to satisfy their need through the RR-Platform. This allows TSOs to optimize the balancing processes on an economical scale across time and benefit the system as a whole. Note that this opportunity is implicitly given to the TSO operators today when they balance the system (in terms of requested volumes for different balancing products) because the balancing processes (RR, mFRR and aFRR) are not separated.

The TSOs who will submit elastic needs, have alternatives to satisfy their needs, either with faster balancing energy products, i.e. aFRR or mFRR, or with local specific products. The TSO chooses to price the need taking into account the price of the alternative. The elasticity clearly helps to reduce the balancing costs, as the TSO will then satisfy this need with a much lower cost, through the alternative product.

In case the TSO cannot price its need, this will affect the volumes submitted to the balancing platform. More specifically, the TSO will only submit a lower amount of volume which cannot be covered by the cheapest alternative products. In general, if the realization of the RR balancing energy need is uncertain (which is often the case, as the TSOs have to submit it before the TSO-TSO Gate Closure Time) without elastic demands, the TSOs would wait and place the balancing energy need at a later point, and would choose not to satisfy it through RR-Platform. By using elasticity, TSOs can use RR in order to balance the system in a cost efficient way, by limiting the financial risk.

It is under the responsibility of the local NRAs to monitor and evaluate the approach that each TSO will follow to price a need. Each NRA will have knowledge of the principle and criteria used by the concerned TSO to fix the elastic price, if this is the case, as well as the curves submitted to the RR platform and the obtained results.

Tolerance band

The tolerance band is a parameter of the balancing energy need submitted by a TSO that reflects the willingness of the TSO to satisfy a higher absolute volume of the balancing energy need than requested with the submitted need, if this optimize need coverage. Since a TSO bid can be divisible, there is no need to consider a tolerance band in the opposite direction to the submitted need.

It is particularly useful when a large amount of indivisible Bids are submitted, as it reduces the number of Unforeseeably Rejected Bids. Note that if all submitted Bids are divisible, then the tolerance band will not be used by the AOF. We illustrate this functionality by the following example.

Example: tolerance band

In this example, we consider only one TSO having a single elastic balancing energy need of 300MWh at 70€/MWh. The tolerance band is 50MWh. We also assume that there are two Bids: an upward Bid of 320MWh at 50€/MWh and a second divisible upward Bid of 400MWh at 60€/MWh. In the first case (on the left side), the upward Bid (UO) is divisible, whereas in the second case (on the right side) it is an indivisible Bid.

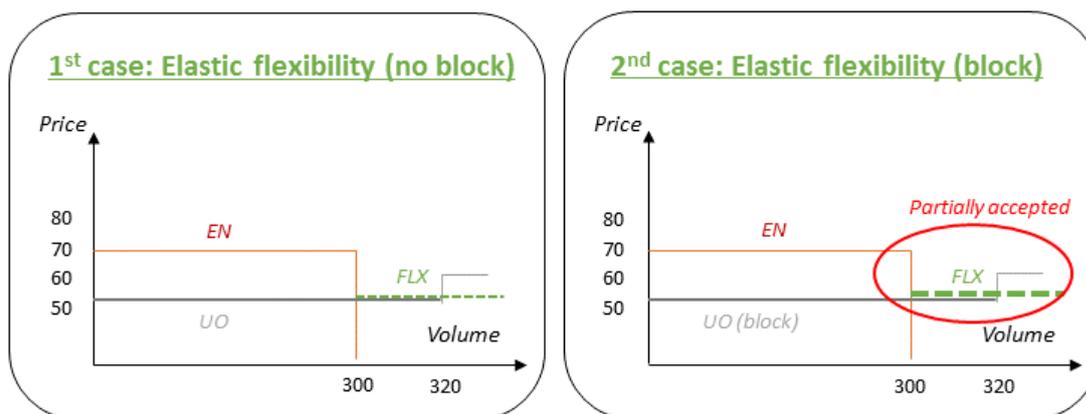


Figure: Example of tolerance band

In the first case, the existence of tolerance band on the elastic TSO balancing energy need is useless, as the algorithm will maximise the welfare without using the flexibility. Thus, the tolerance band is not used, and the TSO's balancing energy need is fully satisfied. The social welfare is equal to 6000€ and the marginal price is equal to 50€/MWh.

In the second case, the tolerance band of the elastic TSO balancing energy need allows the use of the UO indivisible, and increases the social welfare compared to the situation where the need was inflexible. In this case, the indivisible Bid is fully accepted and the tolerance band is partially used (20MWh). Hence, the TSO has a satisfied balancing energy need of 320MWh. The social welfare is equal to 6000€ and the marginal price is equal to 50€/MWh.

Note that if the balancing energy need was not flexible, i.e. had no tolerance band, 300MWh from the second divisible Bid would be activated. In this case, the social welfare would be equal to 3000€ and the marginal price equal to 60€/MWh. Therefore, the upward indivisible Bid would be a URB.

7. Description of the Activation Optimization Function

Additionally to the description included in Article 13 of the RRIF, this section gives more explanation on the Activation Optimization Function.

7.1. Social welfare

The objective function of the activation optimization function (AOF) used by TERRE is the maximization of the social welfare. As defined in Article 29(1) of the GLEB, *each TSO shall use cost-effective balancing energy bids available for delivery in its control area*. The optimization of the social welfare ensures that the cheapest feasible combination of the available balancing energy bids, respecting all constraints, will be activated. Note that if all needs submitted by the TSOs are inelastic, the results of the optimization of the social welfare by the AOF are equivalent to the results obtained by the minimization of procurement costs.

As described in section 6 the TSOs can submit both elastic and inelastic needs. For the inelastic needs, a price corresponding to the IT price cap of the LIBRA platform is considered, in order for them to be included in the calculation of the social welfare. Note that the most expensive BSP upward (downward) bid has always a lower (higher) price than the price assigned to the inelastic needs. Therefore, if all needs submitted by the TSOs are inelastic, the maximization of the social welfare results in the same solution, i.e. the same accepted bids, with the minimization of the procurement costs. We illustrate this property using the following example.

Example

We consider an upward inelastic need, two upward bids and one downward bid, and an IT price cap equal to 100'000€/MWh. As presented in Figure 8, the maximization of the social welfare results in the activation of the upward bids 1 and (a part of the bid) 2, the satisfaction of the upward inelastic need and a marginal price equal to 1'000€/MWh. The social welfare is equal to the TSO surplus plus the BSPs' surplus. The TSO surplus is $100 \cdot (100'000 - 1'000)$ and the BSPs' surplus is $50 \cdot (1'000 - 100) + 50 \cdot (1'000 - 1'000)$. Therefore the social welfare is 9'945'000€. We observe that the inelastic need has a major impact on the social welfare. As the main objective of the AOF is the maximization of the social welfare, the AOF aims at satisfying the inelastic needs, if feasible, at any cost.

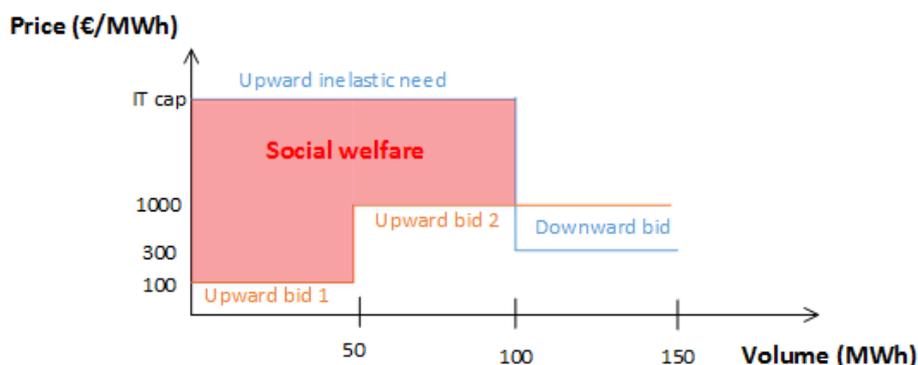


Figure 8: Maximization of social welfare: results of the example

If the objective function was the minimization of the procurement costs, no price would be assigned to the inelastic need. This would result in the activation of the upward bids 1 and (a part of the bid) 2, to the satisfaction of the inelastic need and to the same marginal price. Therefore, if no elastic needs are submitted, the maximization of the social welfare is equivalent to the minimization of the procurement costs.

7.2. Counter-activations

7.2.1. Definition of counter activations

With the term counter-activations, we refer to the simultaneous activation of an upward and a downward Bid in order to increase the social welfare. Due to the fact that all positive and negative TSO balancing energy needs, as well as all upward and downward Bids are treated in a single optimisation, counter-activations could occur if some downward Bids had higher prices than some upward Bids, i.e., if some BSPs would be willing to pay higher prices to reduce their production than the prices some other BSPs would be willing to receive to increase their production.

The figure below presents a merit order list. If a downward Bid - illustrated with blue - has a higher price than an upward Bid (illustrated with orange), then these two Bids would be simultaneously activated, as this would result in a higher social welfare.

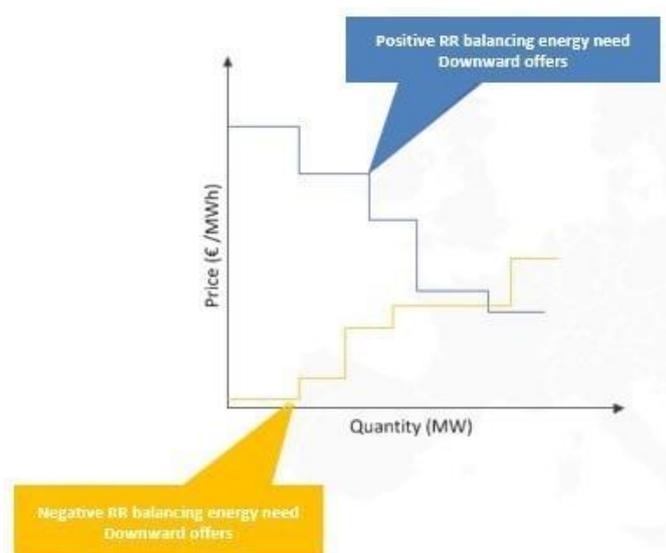


Figure: Counter-activations' explanation

7.2.2. Monitoring and minimising counter activations

RR TSOs take into account the concerns of the Stakeholders and NRAs. Therefore as stated in the RRIF, LIBRA will:

- allow counter activations for the first year and monitor the (1) frequency, (2) volume, (3) impact on CZ marginal price, (4) URBs, (5) computation time and (6) social welfare during the period
- minimize counter activations one year after TERRE go-live

RR TSOs are currently working on a methodology to minimize counter-activations. The current proposal consists of splitting the volumes of needs and Bids into the following factors:

- Need-to-need matching (i.e. netting)
- Need-to-Bid matching
- Bid-to-Bid matching (i.e. counter activation)

Therefore, each need will be represented by two variables, and similarly each bid will be split into two separate variables. This decomposition allows for the algorithm to define the counter activated volumes, i.e. the Bid-to-Bid matching. Using this split, the clearing algorithm can:

- maximize need satisfaction
- minimize counter activations (Bid-to-Bid matching)

This means that the algorithm will try to find a decomposition of need-to-need matching, need-to-Bid matching and Bid-to-Bid matching that minimizes the Bid-to-Bid matching while maximizing social welfare.

Please note that some proposals, such as the NRAs one expressed in the common opinion paper following the last project consultations, aimed to minimise the counter-activation might not be technically feasible and is still under technical assessment.

7.3. Unforeseeably Rejected bids

The AOF seeks to optimise the social welfare of the TERRE region. In addition, not only divisible offers (with zero minimum quantities), but also more complex balancing energy offer formats are expected to be submitted. Therefore, there may be cases where a rejected upward (downward) balancing energy offer has a lower (higher) price than the marginal price. These offers are named unforeseeably rejected bids (URBs). The URBs might also occur in the case of Interconnection Controllability.

The RR TSOs have presented two options regarding URB:

1. allow unforeseeably rejected divisible bids
2. allow only unforeseeably rejected complex offers and minimize unforeseeably rejected fully divisible offers

Considering the feedback of the stakeholders, RR TSOs initially aimed to implement the second option. However, this option will increase the counter-activations and may result in unsatisfied inelastic need which may endanger the system security. An example with a non-satisfied need due to restriction of URBs is presented below. Therefore, the RR TSOs will implement the option 1 and will monitor the URBs.

Example

We consider an area with an inelastic upward need of 30 MWh, a fully divisible upward bid of 20MWh with a price 0 €/MWh and an indivisible upward bid of 20MWh with a price 60 €/MWh. We consider a technical market cap of 100 €/MWh (for illustration purposes here – the market cap will be much higher). The common merit order list consisting of bids and needs is presented in Figure 9.

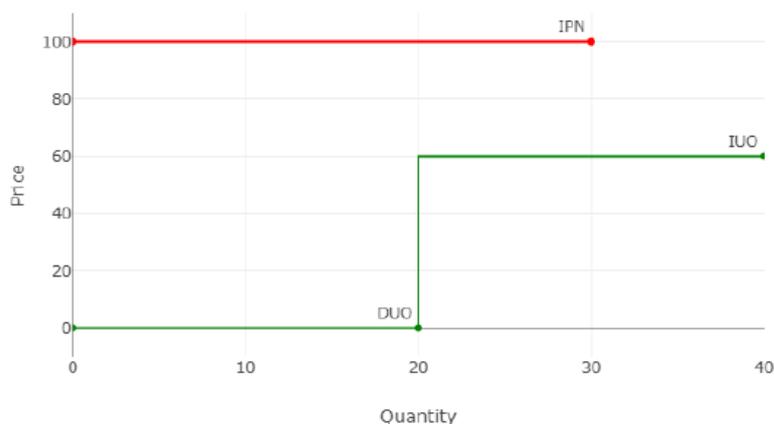


Figure 9: Common merit order list

If fully divisible bids will not be allowed to be rejected, then the fully divisible bid will be accepted and the indivisible bid will be rejected. Therefore, the inelastic need will be partially satisfied. This is not acceptable by the TSOs, as the non-satisfaction of an inelastic need may endanger the system security. Thus, option 1 will be applied, resulting in the acceptance of the indivisible upward bid, partial acceptance of the fully divisible bid and full satisfaction of the inelastic need.

8. Treatment of HVDC and AC energy losses

Grid losses are a physical reality of both HVDC and AC grid. This implies that each allocation on a border with losses ends up with an allocation volume in the exporting area which differs from the allocated volume in the importing area. The AOF will consider the losses on the HVDC interconnectors, whereas losses in AC links will not be considered, as currently done by the day-ahead market coupling. The explanation below is compliant with day-ahead market coupling proposal.

It was concluded that the optimal way to consider losses incurred by an exchange across HVDC interconnectors is to include them directly as an explicit constraint on cross-zonal exchanges in the AOF. More specifically, losses will be included in the overall supply and demand equilibrium constraints of the bidding zones with HVDC interconnectors, as illustrated in the figure below. In addition, losses are considered to be linear to the flow exchange, i.e., they are a fixed percentage of the scheduled exchange as specified by the operators and they are applied based on the overall interconnector loss value, unlike the value to mid-interconnector, as detailed below.

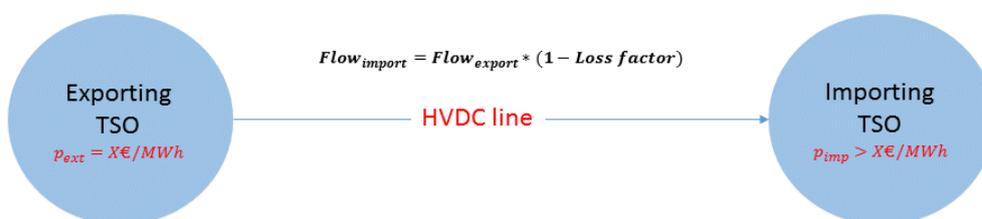


Figure: Losses in HVDC interconnectors

The high level properties on scheduled exchange, prices and congestion rent are the following:

- $Flow_{import} = Flow_{export} * (1 - loss\ factor)$

- $P_{import} * (1 - loss\ factor) - P_{export} = 0$ when no congestion and there is no congestion rent, even if there is a price differential.
- $P_{import} * (1 - loss\ factor) - P_{export} > 0$ when the line is congested and thus there is a congestion rent, calculated as: $P_{import} * Flow_{import} - P_{export} * Flow_{export}$

Note that this does not hold for adverse flows, i.e. flows from a more expensive to a cheaper area that may occur due to e.g., interconnectors' controllability constraints.

For IFA, as the algorithm does not recognize the mid-channel reference, we consider the IFA combined Loss Factor equal to $1 - (1-LF) / (1+LF)$, with LF being the Loss Factor at mid-channel.

The social welfare is also decreased by those losses that can be calculated as:

$$\sum_{all\ interconnectors} (Flow_{export} * p_{export} - Flow_{import} * p_{import})$$

Those financial costs of HVDC losses are therefore implicitly borne by all TSOs members (not always proportionally though), as the consideration of losses directly affect the prices in the respective borders.

9. Interconnection controllability

The calculation of the capacity offered to the market is fundamentally different between AC and DC borders. On DC borders (within the GB market and elsewhere) the nameplate rating is generally offered into the market (i.e. no capacity is held in reserve to cater for faults, operational issues etc.). However this is not the case for AC borders where capacity can be reduced to cater for operational requirements (e.g. n-1).

For DC borders, this can lead to times where the market benefit that the extra capacity brings is outweighed by the operational costs of providing the capacity. Therefore, to avoid such situations and maximize social welfare, TSOs need to manage HVDC links in operational timescales as certainty of power system conditions increases. TERRE allows these TSOs to manage HVDC links by submitting to the RR-Platform a desired flow range across the HVDC.

Some RR TSOs decided to extend this functionality which was first considered for HVDC links also to AC borders and implement interconnection controllability within RR-Platform. This change in cross-zonal exchange is implicitly converted as a constraint in the algorithm. Each TSO defines hence new bounds for the bilateral commercial exchange for the border to be controlled. If the new bounds are respected by reducing the available capacity across the respective border, the available capacity reduction is done before the RR-Platform process, in the same way as today. However, if a reversal of the exchange is required to respect the new bounds, the TSO can define a minimal desired exchange in a specific direction (i.e. a negative capacity). The AOF constrains the flow across the specific border, considering the desired exchange submitted by the TSO. Note that this is a hard constraint; therefore it will be respected irrespectively of the cost.

The offers that will be accepted by the optimisation algorithm, and hence, will be activated, will respect the constraint of the desired exchange. However, the settlement between TSOs will be done based on the marginal prices resulting from the algorithm without considering the desired exchange constraints. The accepted offers activated to respect the constraint of the desired flow range (and not accepted without considering such constraint) will be paid to the BSPs based on pay-as-bid aiming to comply with Article 30 of the EBGL.

We consider the following example to explain the aforementioned activations and settlement option.

Example:

We consider the system depicted in Figure 1 below and the offers presented in Table 4 below. For the sake of simplicity, all offers and needs have a validity period equal to the market time unit, i.e. 60 minutes, and all needs are considered to be inelastic and inflexible. The cross-zonal capacity between TSOs 2 and 3 is large enough so as not to influence the results, whereas the submitted cross-zonal capacity between TSO 1 and 2 is 50MW for the one direction (1 -> 2) and 0MW for the opposite direction (2 -> 1). As illustrated in Figure 1 and Table 1 below, TSO 1 submits a desired minimum flow of 30MW.



Figure 1: Example Interconnection Controllability

TSO	Offer direction	Offer quantity (MW)	Offer price (€/MWh)
1	Upward	40	50
1	Upward	50	60
2	Upward	60	60
2	Downward	50	-35
3	Upward	80	30
3	Upward	90	40
3	Downward	50	-5

Table 1: Example Interconnection Controllability: submitted offers

The AOF considers the desired flow of 30-50MW and gives the results presented in Figure 2 and Table 2 below.



Figure 2: Example Interconnection Controllability: results

TSO	Offer direction	Offer quantity (MW)	Offer price (€/MWh)	Activated quantity (MW)
1	Upward	40	50	40
1	Upward	50	60	10
2	Upward	60	60	0
2	Downward	50	-35	0
3	Upward	80	30	70
3	Upward	90	40	0
3	Downward	50	-5	0

Table 2: Example Interconnection Controllability: activated offers

The AOF will be executed once more (sequentially or in parallel with the first run), without considering the minimum desired flow constraint. The results of the second unconstrained run are presented in Figure 3 and Table 3 below.



Figure 3: Example Interconnection Controllability: results of unconstrained run

TSO	Offer direction	Offer quantity (MW)	Offer price (€/MWh)	Activated quantity (MW)
1	Upward	40	50	20
1	Upward	50	60	0
2	Upward	60	60	0
2	Downward	50	-35	0
3	Upward	80	30	80
3	Upward	90	40	20
3	Downward	50	-5	0

Table 3: Example Interconnection Controllability: accepted offers in the unconstrained run

The price at the bidding zone of the TSO 1 will be 50€/MWh, and the price at the bidding zones of the TSOs 2 and 3 will be 40€/MWh. Note that the accepted offers of the constrained run, presented in Table 2, are activated but the marginal price is the result of the unconstrained run.

As aforementioned, some uplifts will be given to BSPs that were activated but had higher submitted price for upward offers (or lower submitted price for downward offers). More specifically, these BSPs will be paid with pay-as-bid. In the above example, this holds only for one offer: from the area of TSO 1, an offer with submitted price 60€/MWh was activated, but the marginal price is 50€/MWh. This offer will thus be paid with 60€/MWh instead of 50€/MWh. Note that this offer belongs to the TSO 1 who requested the Interconnector Controllability, and will hence not affect the TSO-TSO settlement. The uplift given to this BSP, i.e. $60\text{€/MWh} \cdot 10\text{MW} - 50\text{€/MWh} \cdot 10\text{MW} = 100\text{€}$, will come from the TSO 1 who requested the controllability.

The TSOs will be transparent on the interconnection controllability usage. The TSOs also consider that any potential "missed activations" due to the consideration of the interconnection controllability are linked to the security of network which is under the mandatory responsibility of the TSOs.

10. TSO-TSO settlement

As a consequence of the exchange of balancing energy in RR-Platform, there will need to be a settlement mechanism between the TSOs.

The key features of the TSO-TSO settlement are:

- Settlement of the energy exchanged based on pay-as-cleared, following the guidance provided by the EBGL
- The energy commercially scheduled and settled between the TSOs will be the energy block over the corresponding period (not including the possible energy associated to the ramps outside the period), in line with the definition of RR standard product for RR (see Figure 1 below).



Figure 1: Energy volume scheduled and settled at cross-zonal level in TERRE

10.1. Congestion rent

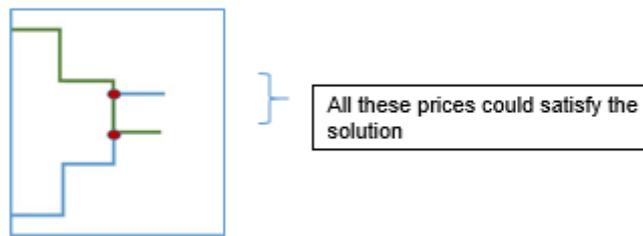
There could be situations where borders within RR regions become congested. In such a case, there could be different marginal prices on each interconnected bidding zone. Each of these prices will be established based on the activated balancing offers and/or the satisfied TSOs balancing energy needs in the non-congested area. Due to this price difference between the price that an area is “willing to pay” and the price that the other area is “willing to receive” at either side of the interconnector, a surplus will occur. This surplus, calculated as the multiplication of the exchanged balancing energy times the price difference, is called a “congestion rent” in other timeframes (such as the MRC project). In this case, the “RR congestion rent” would be:

$$\text{RR congestion rent} = \text{RR schedule} \times (\Delta\text{Price})$$

The RR schedule is the cross-zonal schedule between the two congested areas and ΔPrice the difference of marginal prices at both sides. The distribution of congestion rents is a regulatory issue that shall be established with the input from the NRAs. These congestion rents do not only occur in the RR-Platform but also in other timeframes (e.g. Multi Regional Coupling in DA). Therefore the use of this congestion rent will be consistent with how it is used in other timeframes, and in line with the Regulation R 714-2009 article 16-6.

10.2. Price indeterminacy

A price indeterminacy is a special situation when identical bid and demand selection lead to multiple optimal clearing price solutions, as depicted the figure below. In this case, all solutions have an identical social welfare and is therefore necessary to define a rule to choose a single price between the set of optimal prices. This situation can occur either due to the presence of elastic demands or due to scheduled counter-activations.



To calculate the price, we consider an upper and a lower price bound and the price is set at the middle of these bounds. If no upper price bound is available, e.g. there are no accepted single BTU downward bid or elastic need and no rejected fully divisible upward bid or elastic need, then the price is set at the lower bound. Similarly if no lower price bound is available, e.g. there are no accepted single BTU upward bids or elastic needs and no rejected fully divisible downward bid or elastic need, then the price is set at the upper bound. To define the bounds, the prevention of Unforeseeably Accepted Bids for single BTU bids and the prevention of Unforeseeably Rejected Bids (if counter-activations will be allowed) for fully divisible bids and elastic needs are taken into account.

The following example illustrates a price indeterminacy situation with fully divisible bids (simplest scenario).

Example

We consider the following balancing energy needs and Bids:

- IPN: inelastic upward need of 10 MWh and 100 €/MWh (assumed market cap)
- DDO1: fully divisible downward bid of 10 MW and 80 €/MWh
- DDO2: fully divisible downward bid of 10 MW and 0 €/MWh
- DUO1: fully divisible upward bid of 20 MW and 20 €/MWh
- DUO2: fully divisible upward bid of 10 MW and 40 €/MWh

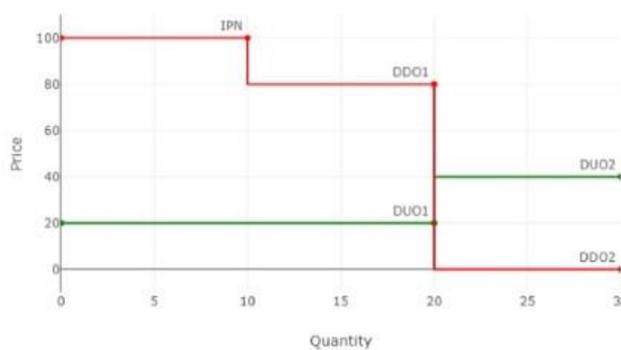


Figure 10: Price indeterminacy example

If counter-activations are allowed, then the bids DUO1 and DDO1 as well as the inelastic need IPN are accepted and the price bounds are defined as follows:

- $MCP \geq 20\text{€/MWh}$ (UAB rule for DUO1)
- $MCP \leq 80\text{€/MWh}$ (UAB rule for DDO1)

- $MCP \geq 0\text{€}/\text{MWh}$ (URB rule for DDO2)
- $MCP \leq 40\text{€}/\text{MWh}$ (URB rule for DUO2)

Therefore, the final upper price bound is 40€/MWh and the final lower price bound is 20€/MWh. The price is set at the middle point, and is therefore equal to 30€/MWh.

If counter-activations are minimized, then the bid DU01 will be partially accepted (10MWh) and the inelastic need will be satisfied. The URB rule will not be taken into account to define the price bounds, and the only price bound comes from the acceptance of the DU01. Therefore, the price will be set at 20€/MWh.

Note that the Day-Ahead market uses a different definition for the price target since it only considers fully divisible bids (called “hourly orders”) for their determination. The main reason for the Day-Ahead approach is to ensure a better share of surplus between fully divisible bids, thus disregarding other types of bids.

Instead, the LIBRA optimization module considers all single BTU bids (including indivisible bids) since it is a more natural approach and it increases the chances to generate both lower and upper price bounds.

11. Cross border scheduling steps and number of daily gates

The RR TSOs commit to reduce the cross border scheduling steps less than 60min for the borders included in the RR region. The deadline will be the date required by the EBGL for using the European Platform for exchange of mFRR and the date required by the CACM regulation for the intraday cross zonal gate closure frequency definition.. From this deadline, the cross border scheduling step will be 15min.

Starting from this date, some TSOs are likely to increase the number of daily gates (daily clearing) to 48 and 96 gates. For example, RTE and Swissgrid aim to implement 48 daily gates.

Depending on the maturity of the European balancing market at that time, TSOs will perform an analysis on the increase of daily gates.

12. GCT for RR energy bids (BEGCT)

The TSOs understand the Stakeholders position regarding the BEGCT definition. It is why the RR TSOs committed in the RR IF Article 7 to define the BEGCT at 55min before the period which is concerned by the activation of the RR standard product to satisfy the TSO balancing energy need.

This target will be reached no more than 12 months after the go-live of the RR-Platform. During these 12 months, the BEGCT will be set up at 60min before the period which is concerned by the activation of the RR standard product to satisfy the TSO balancing energy need.

This proposal was made in order to give time for some RR TSOs to bring enough experience from RR-platform process combined with XBID process. These 12 months will allow those RR TSOs to adapt their local processes and tools and therefore decrease the time needed for the following tasks:

- Reception, treatment, filtering, converting (for CDS systems) and sending the offers to the platform, calculation of total offered volume
- Calculation of margins
- Reception, validation of XB schedules, calculation of new schedules, calculation and sending remaining ATC
- Reception, integration of specific schedules
- Calculation of imbalance based of XB schedules, generation schedules
- Calculation of imbalance need and its associated price
- Manual review of the need and sending to the platform

13. Fall-back process

In the event that the optimisation algorithm does not converge, the following fall-back procedure will be performed:

1. The algorithm will run taking into account the previously submitted balancing energy offers and TSO balancing energy needs, requirements and other constraints, with cross-zonal capacity between all bidding zones equal to 0;
2. The final results will be communicated to the TSOs,

Furthermore, each TSO shall ensure that national fall-back solutions are in place in case the procedures referred to in paragraphs (1) and (2) fail. Thus, if the algorithmic optimisation does not converge with cross-zonal capacity equal to 0, all TSOs will run their national systems, taking into account only their national balancing energy offers and balancing energy need, requirements and other constraints, and, in this case, the TSOs' balancing energy needs will be satisfied only through national offers.

Each TSO can decide to use the national fall-back solution or the solution provided by RR-Platform fall-back procedure.