PROGRESS ON EB GL IMPLEMENTATION

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28 February 2019

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Reliable Sustainable Connected

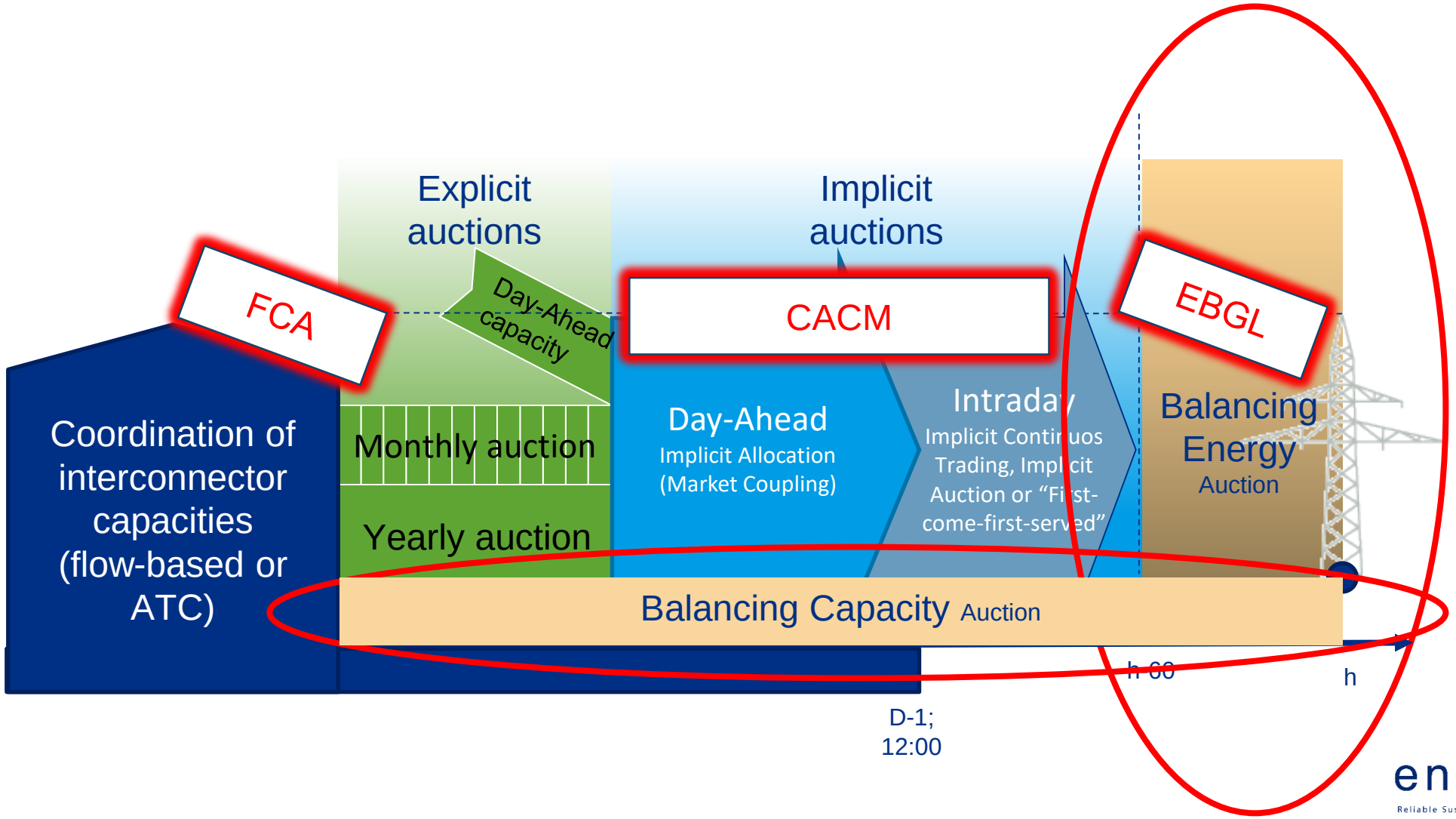
1 Introduction: EB GL

2 European balancing platforms and timelines

3 Summary EB GL proposals

INTRODUCTION:
Guideline on electricity balancing (EB GL)

1. The Internal Energy Market (IEM) and guidelines



1. Ancillary Services

Ancillary services are all services required by the transmission or distribution system operator to enable them to maintain the integrity and stability of the transmission or distribution system as well as the power quality in order to tackle:

- **Electric load** is greater or less than foreseen at the time of market-clearing
- **Renewable energy** generation is greater or less than foreseen at the time of market-clearing
- **Outages** (operational difficulties) of production units or from the transmission equipments
- **Internal congestion** (within market/balancing zone)

- Blackstart capability
- Reactive power
- Frequency control
- Ramping requirements
- Transient stability
- Rate of change of Frequency
- Inertia
- Virtual inertia

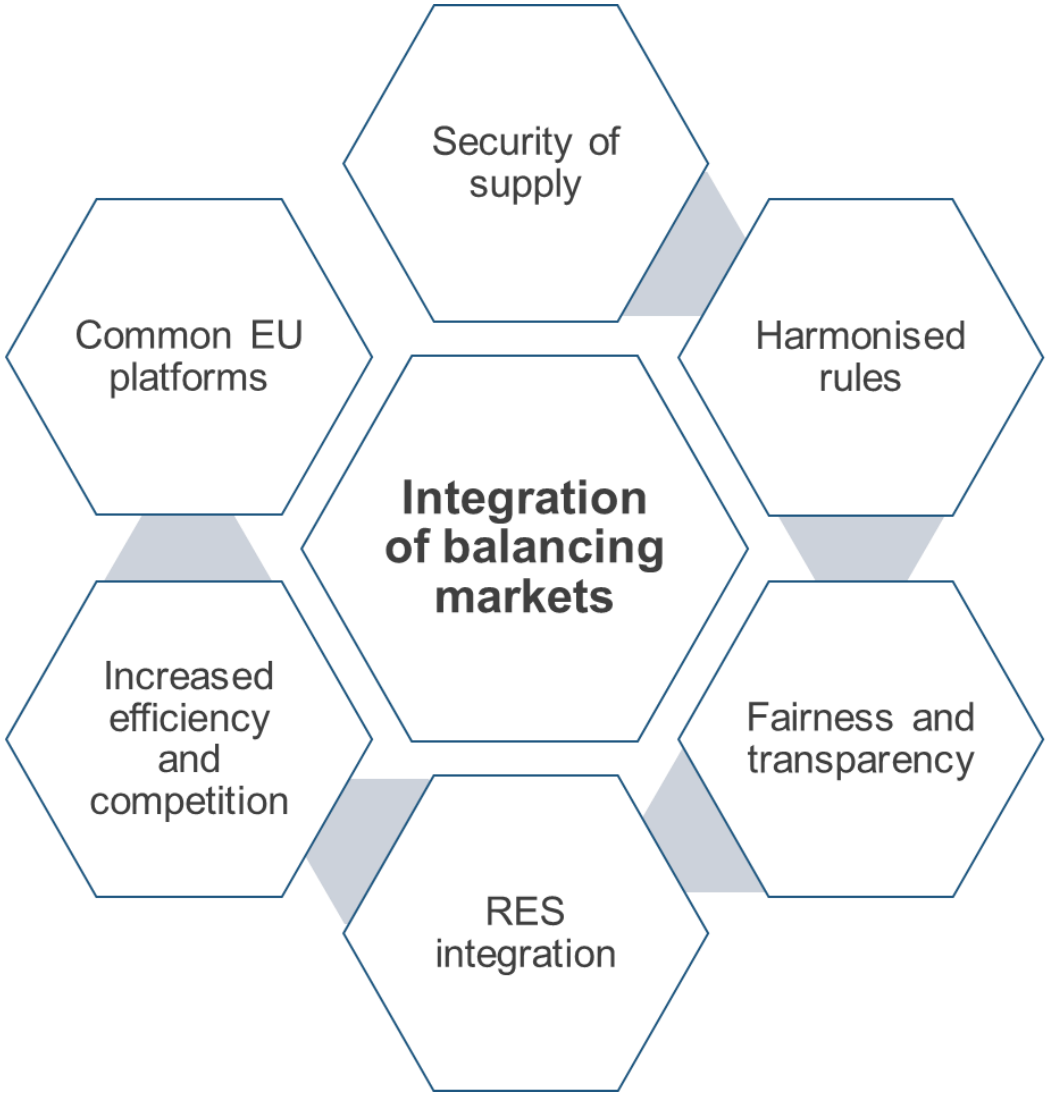
Balancing

Electricity Balancing Guideline covers

- Frequency Containment Process
- Frequency Restoration Process with automatic activation (aFRR)
- Frequency Restoration Process with manual activation (mFRR)
- Replacement Process (RR)

1. What is the purpose of the EB GL?

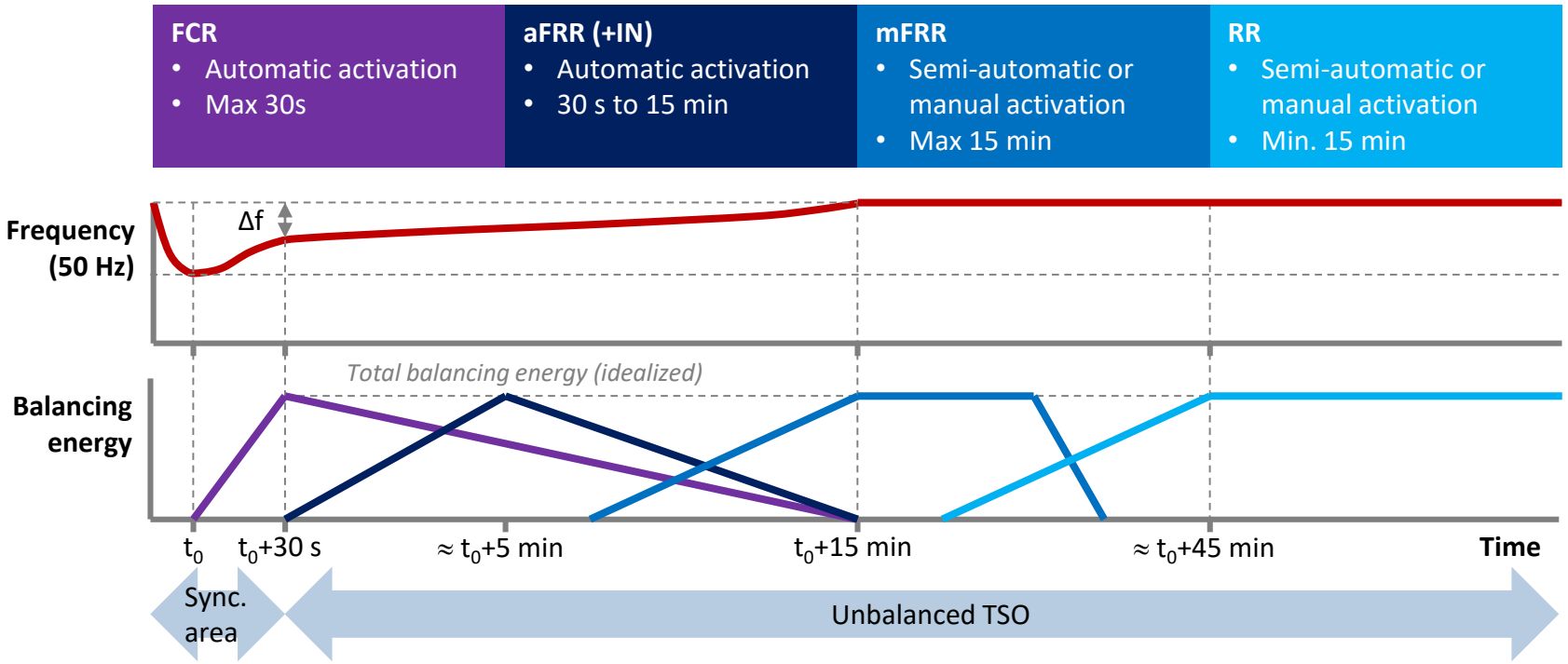
The main target of the EB GL is to **integrate** and **harmonise** balancing energy markets through a TSO-TSO model facilitated by **European platforms**.



1. Market participants involved (1/2)

	BSP (Balancing Service Provider)	**TSOs**	**BRP** (Balance Responsible Party)
Who are they?	Generators, demand-response facilities, storage operators → they **provide balancing services** to TSOs.	ENTSO-E members	A market participant or its chosen representative **responsible for its imbalances**. They could be the same as the BSP.
What they do?	Provide bids in the balancing markets to its connecting TSO[1] (TSO-TSO model) or for the TSO-BSP model[2] to its contracting TSO *(Article 16 of the EBGL)*	Balance the system *(Article 14 of the EB GL)*	Financially responsible for balancing its imbalances on supply and demand for its portfolio (sum of their injections, withdrawals and trades) and keeping their own position balanced over the Imbalance Settlement Period (ISP). *(Article 17 of the EBGL).*
How they do?	Submit bids to their (connecting) TSO.	Self-dispatching Central dispatching	Run a forecast the consumption of the consumers in his portfolio and source the required amount of energy to match that consumption
Why?	Income (pricing of balancing energy)	Balance the electricity market closer to real time (Whereas (8), (9) of the EB GL)	Income (imbalance settlement)
When?	Balancing energy pricing period (BEPP)	BEPP, ISP, TSO-TSO settlement period	Imbalance Settlement Period (ISP)

1. Load-frequency control processes



Up to 5 steps:

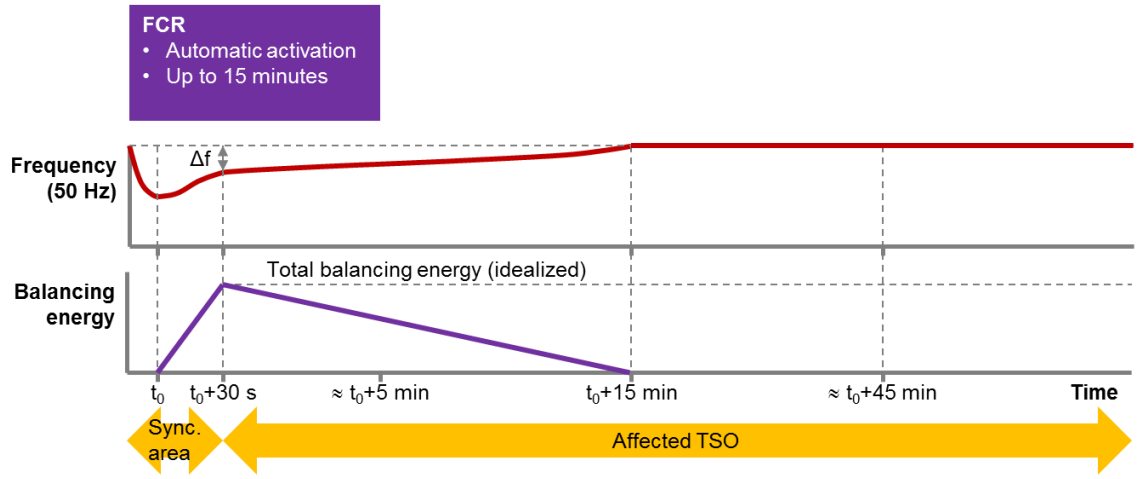
- Frequency containment reserves (**FCR**);
- Imbalance netting (**IN**);
- Frequency restoration reserves with automatic activation (**aFRR**);
- Frequency restoration reserves with manual activation (**mFRR**);
- Replacement reserves (**RR**).

1. Load-frequency control platforms

Frequency Containment Reserves (FCR)

Operational Reserves activated to contain System Frequency after the occurrence of an imbalance frequency deviation means the difference between the actual system frequency and the nominal frequency of the synchronous area which can be negative or positive.

The Frequency Containment Process **stabilises the frequency after the disturbance** at a steady-state value within the permissible Maximum Steady-State Frequency Deviation by a joint action of FCR within the whole Synchronous Area

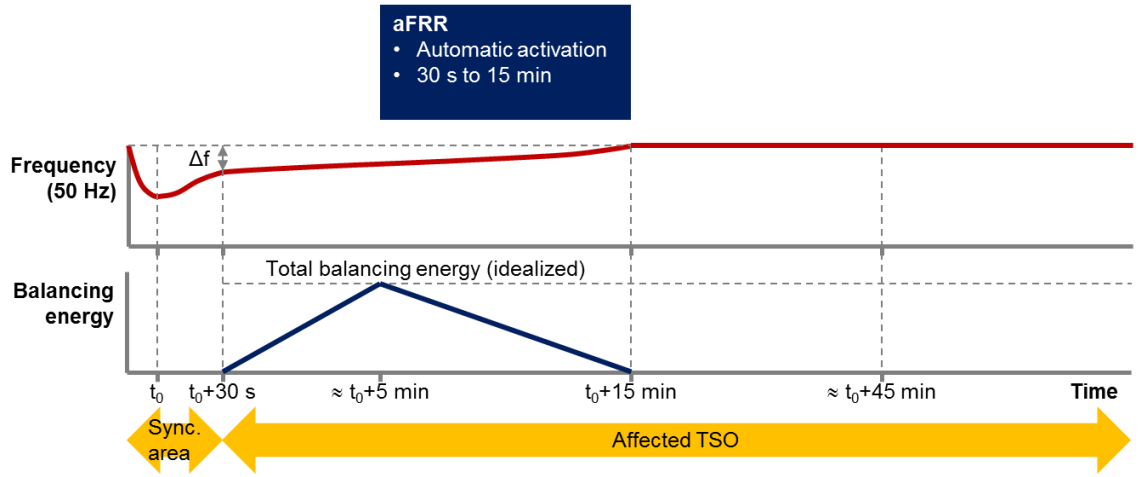


Article 46

Automatic Frequency Restoration Reserves (aFRR)

The Frequency Restoration Process controls the frequency towards its setpoint value by activation of FRR and replaces the activated FCR.

The Frequency Restoration Process is triggered by the disturbed LFC Area. This type of activation is automatically triggered.

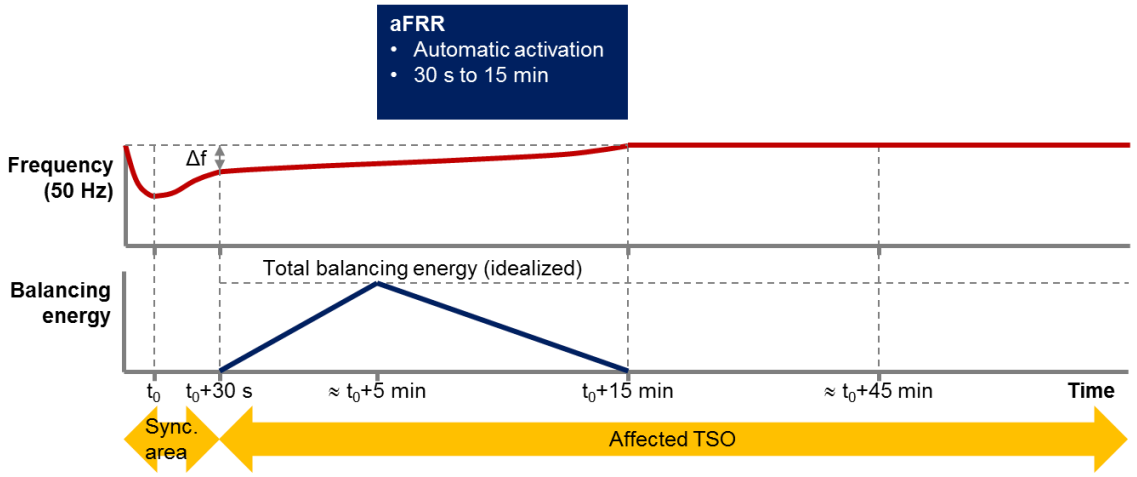


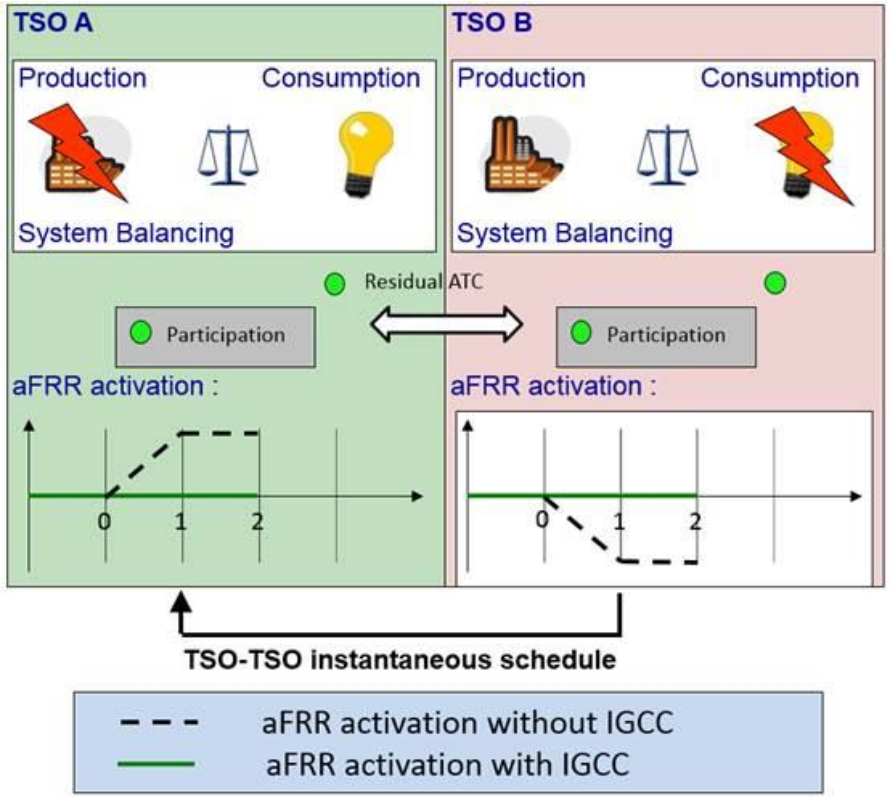
Article 21

1. Load-frequency control platforms

Imbalance Netting (IN)

Imbalance netting is the process agreed between TSOs of two or more LFC areas that allows avoiding the simultaneous activation of frequency restoration reserves (FRR) in opposite directions by taking into account the respective frequency restoration control errors as well as the activated FRR, and by correcting the input of the involved frequency restoration processes accordingly.



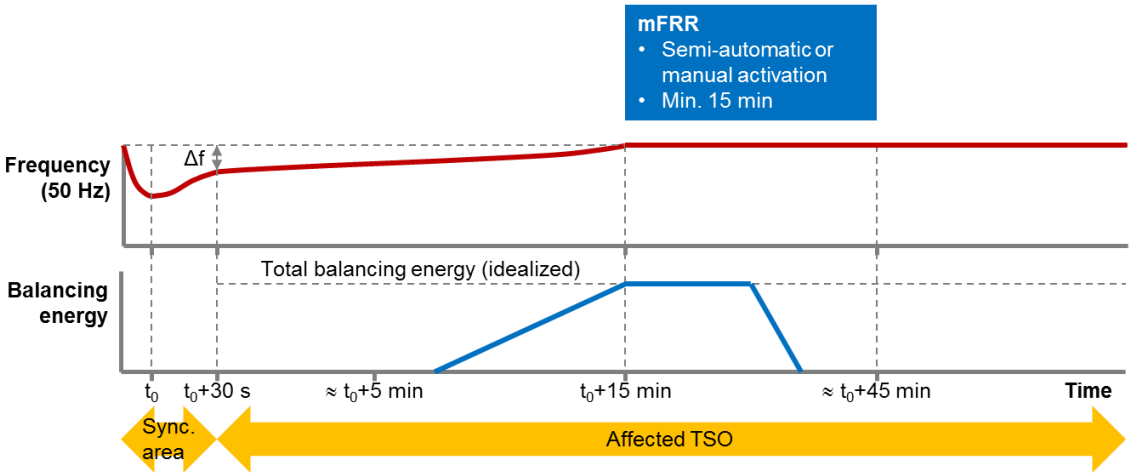


Article 22 of the EBGL

1. Load-frequency control platforms

Manual Frequency Restoration Reserves (mFRR)

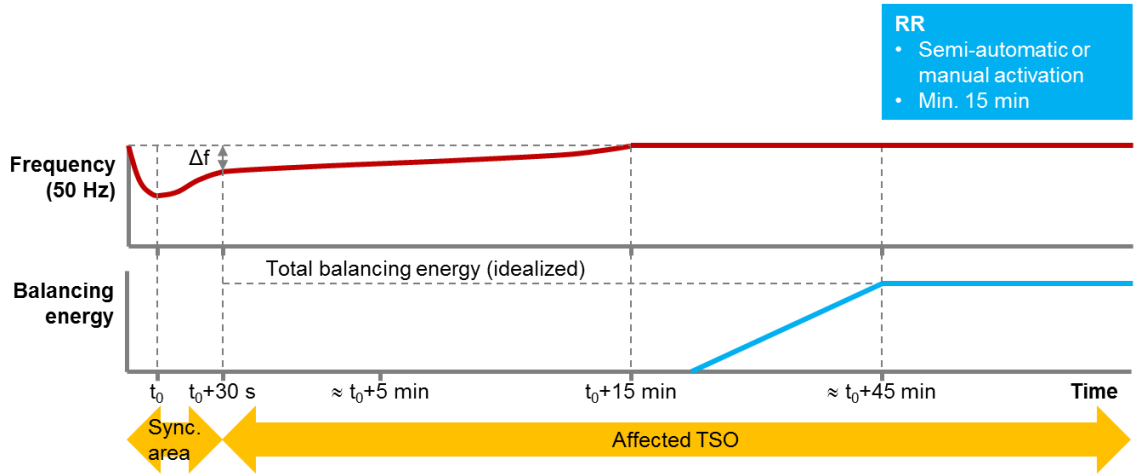
The Frequency Restoration Process controls the frequency towards its Setpoint value by activation of FRR and replaces the activated FCR. The Frequency Restoration Process is triggered by the disturbed LFC Area.
This type of activation is manually triggered.



Article 20 of the EBGL

Replacement Reserves (RR)

The reserves used to restore/support the required level of FRR to be prepared for additional system imbalances. This category includes operating reserves with activation time from Time to Restore Frequency up to hours

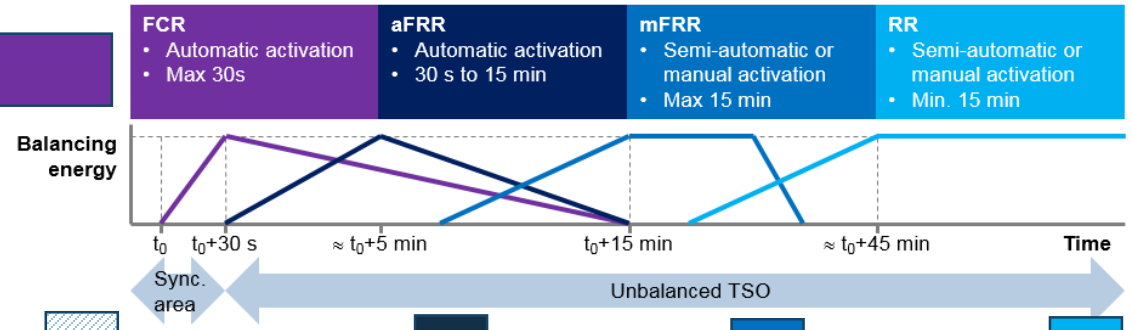


Article 19 of the EBGL

Balancing platforms and timelines

2. Balancing platforms per product/process

No common platform for FCR foreseen in EB GL



Each process has different specifications

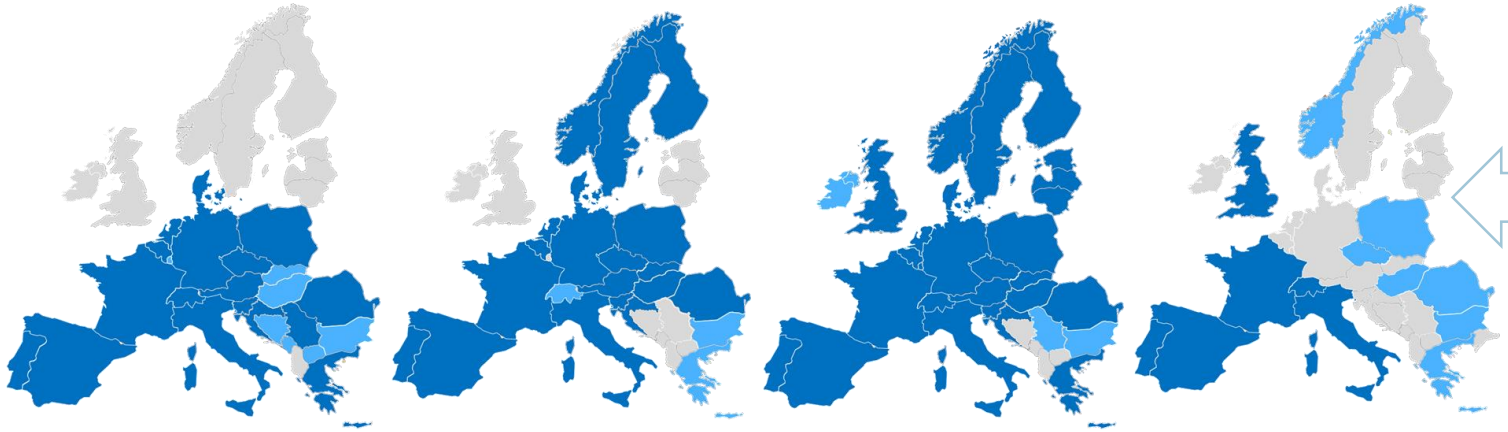
Each process has different timing

Imbalance netting: IGCC

aFRR: PICASSO

mFRR: MARI

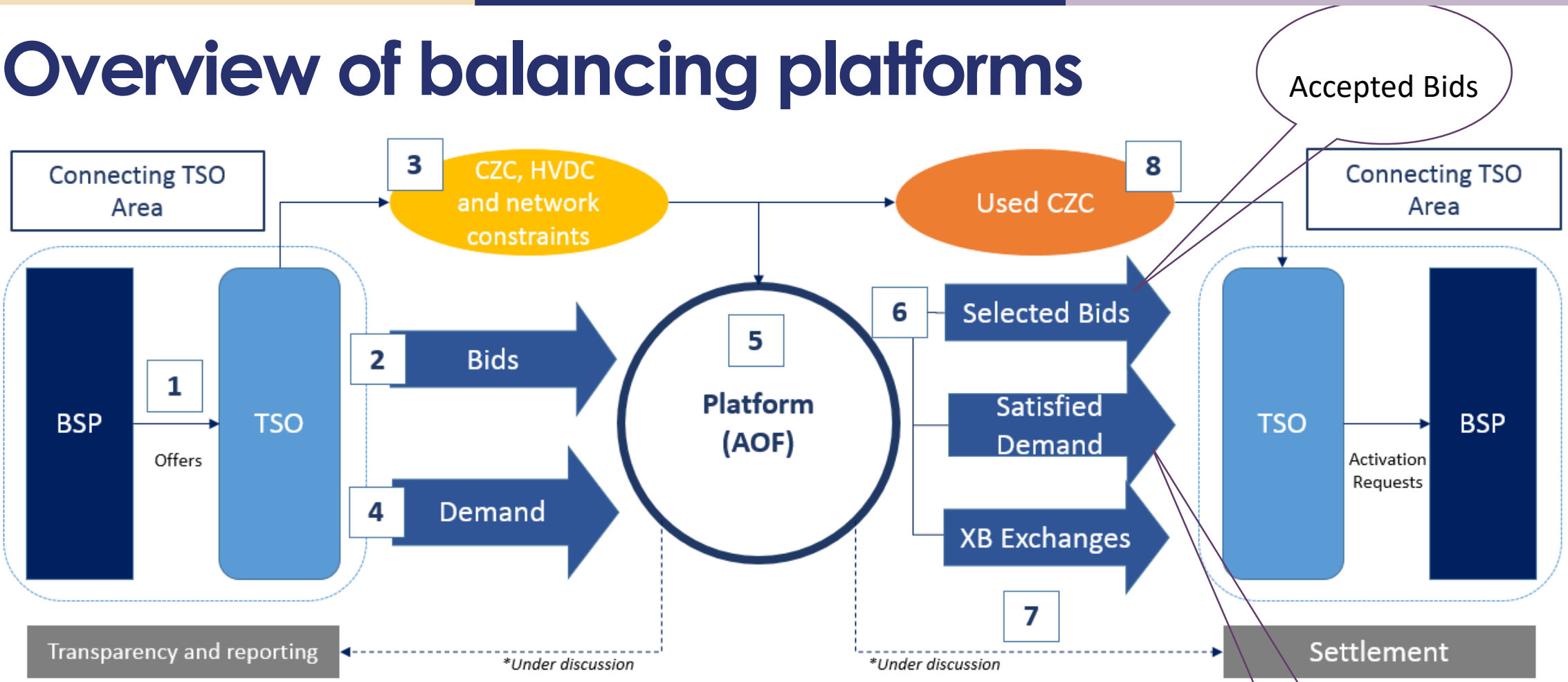
RR: TERRE



Each process has different geographical scope

Member Observer

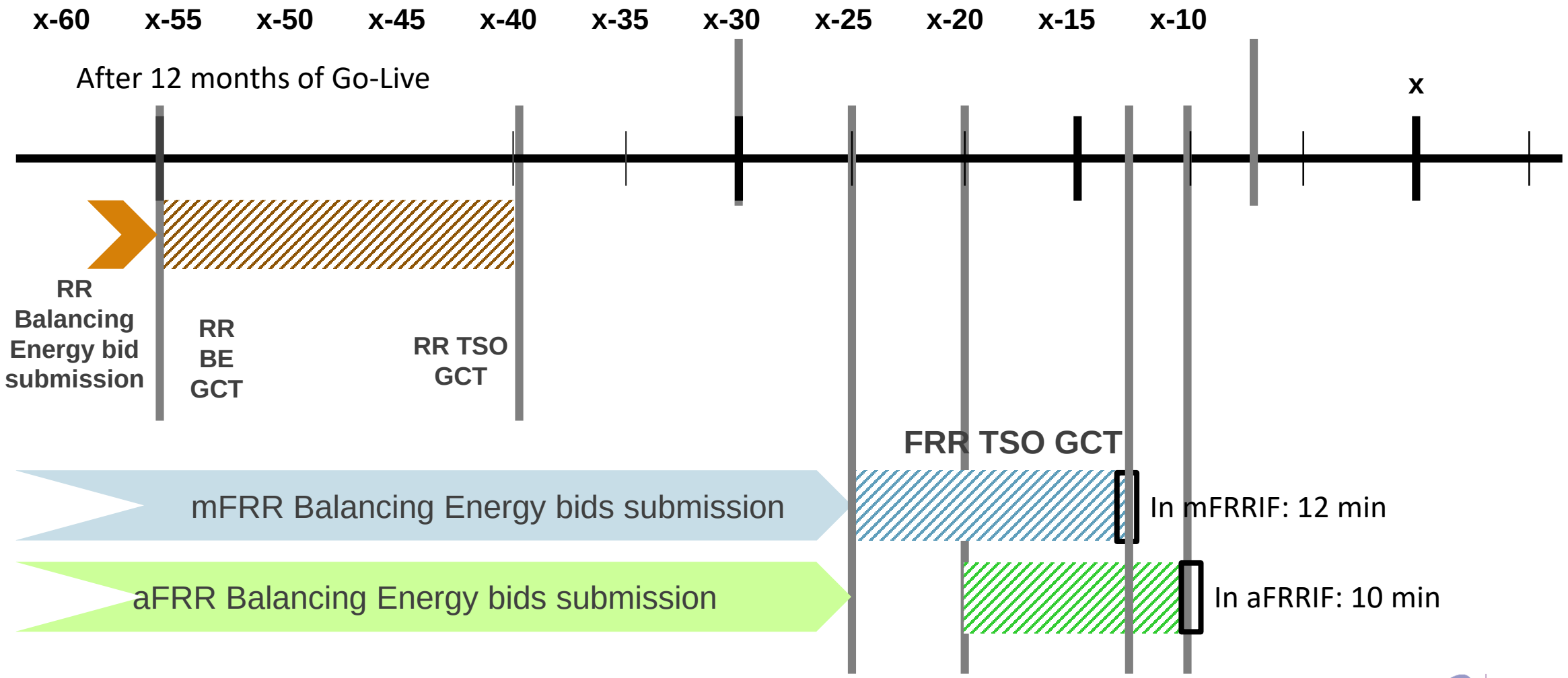
2. Overview of balancing platforms



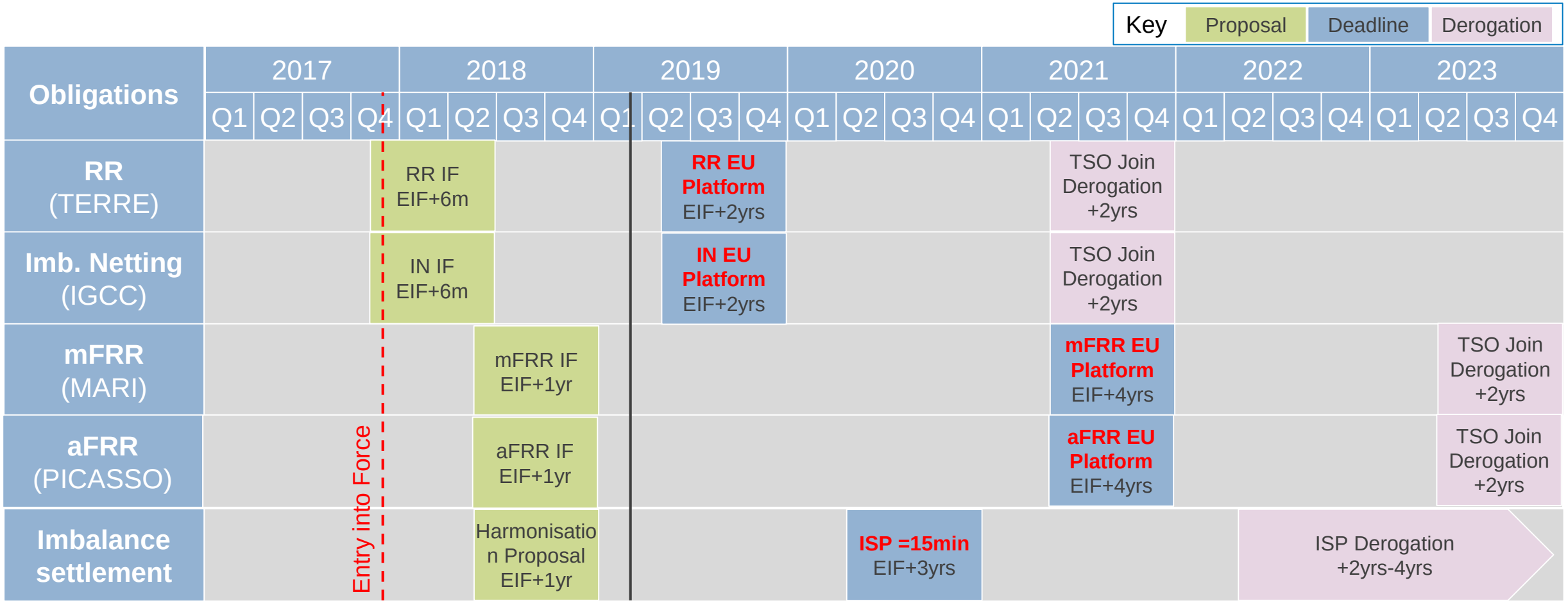
List of abbreviations:

- **CMOL:** Common Merit Order List
- **AOF:** Activation Optimisation Function
- **CZC:** Cross-Zonal Capacity

2. Gate closure time (GCT) of each platform



2. General work plan



IF – implementation framework;
EIF – Entry into force
ISP – Imbalance settlement period

2. Work plan 2019

EB GL All/relevant TSOs and ENTSO-E tasks	Consultation periods 2019	Workshops 2019
Proposal for activation purposes of balancing energy bids		
Proposal for pricing of balancing energy and CZC used for exchange of balancing energy (RR, FRR, IN)		
Proposal for TSO-TSO settlement of intended exchanges of balancing energy (RR, FRR, IN)		
Proposals for TSO-TSO settlement of ramping period energy, FCR and unintended exchanges within and between synchronous areas		
Proposal for harmonisation of certain features of imbalance calculation & pricing		
Proposal for list of Standard Balancing Capacity Products	Expected: July - mid-Sept.	Exp.: July
CZC allocation: methodology for cooptimised CZC allocation	Expected: July - mid-Sept.	4 Feb. + exp. April + exp. July
CZC allocation: methodology for market based CZC allocation (CCRs)	TBD by CCRs	Exp. April + TBD by CCRs
CZC allocation: methodology for CZC allocation based on economic efficiency analysis (CCRs)	TBD by CCRs	Exp. April + TBD by CCRs
CZC allocation: harmonise allocation of CZC		
CZC calculation: methodology for CZC calculation in balancing timeframe (CCRs)		
Proposal for implementation framework for European platform for the exchange of mFRR		
Proposal for implementation framework for European platform for the exchange of aFRR		
Proposal for implementation framework for European platform for imbalance netting process (RfA)		

Summary EB GL proposals

3. Implementation frameworks (1/3)

Implementation frameworks of the European balancing platforms for the exchange of aFRR, mFRR, RR or for the imbalance netting process

Scope	• The **usage of the platforms** is mandatory for: aFRR – continental Europe and Nordics; mFRR – all TSOs; RR – TSOs using RR; IN – continental Europe.
Definitions	• **Balancing borders**: transmission lines linking adjacent LFC areas and/or BZs. • **Cross-border capacity limits**: constraints to the optimisation algorithm to reflect usage or limits to CZC between balancing borders. • **Participating TSO** means TSO physically exchanging through the platform; **member TSO** means that it has joined the platform (legally) but is not exchanging.
Timeline	• **Implementation** by 30 months after approval of aFRRIF & mFRRIF (assumption Dec. 2024) and by 12 months after approval of INIF and RRIF (end-2019 / early-2020).
Entity	• The entity entrusted to operate the functions of the platform shall be a consortium or a company of TSOs.

3. Implementation frameworks (2/3)

Implementation framework of the European balancing platforms for the exchange of aFRR, mFRR, RR or for the imbalance netting process

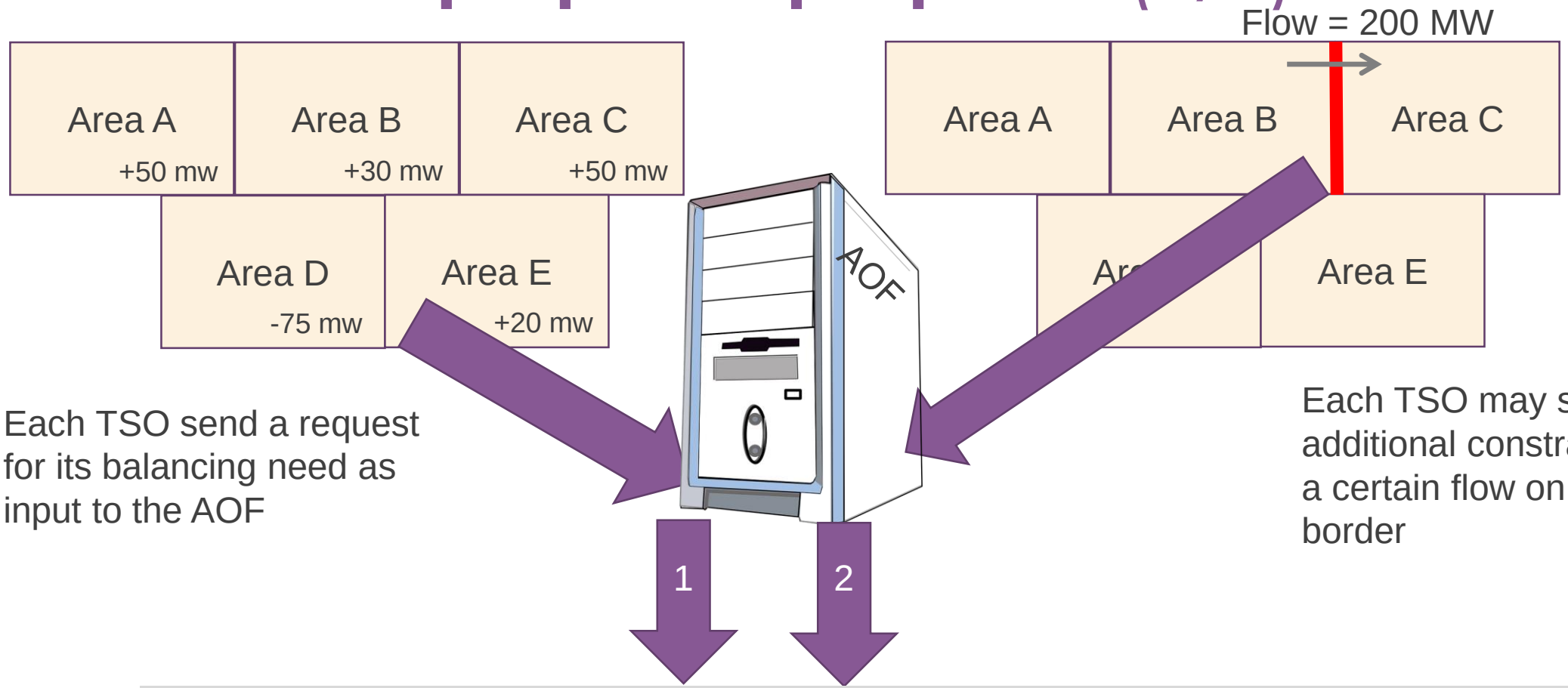
High-level design & functions	• Functions: **AOF** (activation optimisation function) and **TSO-TSO settlement function**. A CZC calculation function may be added.
	  ○ AOF main inputs: demands, cross-border capacity limits, local merit order lists (LMOL), availability status of bids, operational security constraints..
	  ○ AOF main outputs: aFRP power interchanges, volume of activations and of satisfied TSO demands, prices of balancing energy and CZC.
	  ○ TSO-TSO settlement function inputs: prices and power interchanges.
	  ○ TSO-TSO settlement function outputs: settlement amounts (settlement prices x volumes).
	• Each TSO is responsible to calculate the set-point of their controllers for aFRR activations and for prequalification of BSPs.
	• Each TSO shall publish the volumes and prices provided by the AOF no later than 30 min after relevant quarter hour.

3. Implementation frameworks (3/3)

Implementation frameworks of the European balancing platforms for the exchange of aFRR, mFRR, RR or for the imbalance netting process

Governance	• Steering committee + expert group • All TSOs shall **monitor**, **evaluate** and **report** on: implementation progress and roadmap, amount of requested balancing energy, deviation between activation of bids and selection of bids by the AOF, impact on the economic surplus of blocking/allowing counter-activations, bids marked unavailable, efficiency of optimisation-cycle BEPP in case of aFRR and results on annual stakeholder survey on further harmonisation. • All TSOs shall conduct an **annual stakeholder workshop** to report on implementation and operation of the platform.
Further harmonisation of T&C	• **Annual stakeholder survey** to identify prioritised harmonisation needs. • All TSOs shall **consult harmonisation options** for a period of two months. • **Amended implementation frameworks** including harmonisation options every 3 years after the platform becomes operational.

3. Activation purposes proposal (1/2)



Each TSO send a request for its balancing need as input to the AOF

Each TSO may send an additional constraint, namely a certain flow on a specific border

1. The AOF identifies which bids to activate – to solve both constraints in a one step optimisation problem
2. The AOF does a parallel run – to identify which bids to activate, if it only should solve the balancing needs

The difference between the two runs determines the activation purpose for each bid

3. Activation purposes proposal (2/2)

Process	Activation purpose: balancing	Activation purpose: system constraints*	Pricing for balancing purposes (not part of this proposal)	Example of pricing for system constraint purposes (not part of this proposal)
RR	yes	yes	XBMP	(a) ≤ XBMP → XBMP will be applied (b) > XMBP → Pay-as-bid will be applied
mFRR	yes	yes		
aFRR	yes	no		

*System constraints is an activation purpose which does not serve the frequency-control process targets in accordance with the SO GL (frequency restoration process and reserve replacement process)

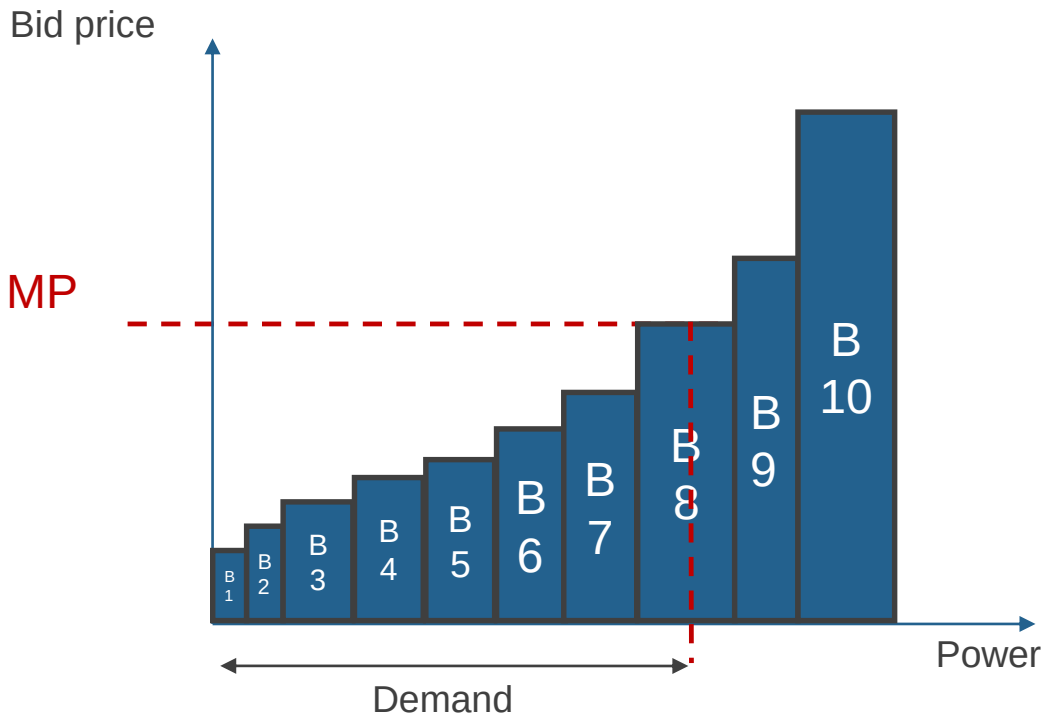
3. Pricing proposal (1/5)

Scope	• Pricing of balancing energy products (TSO-BSP) and CZC for the exchange of balancing energy or for the imbalance netting process

Marginal pricing as basis of the proposal

In this context, the marginal price (MP) represents the price of the last bid of a standard product which has been activated to cover the energy need for balancing purposes within a specified area.

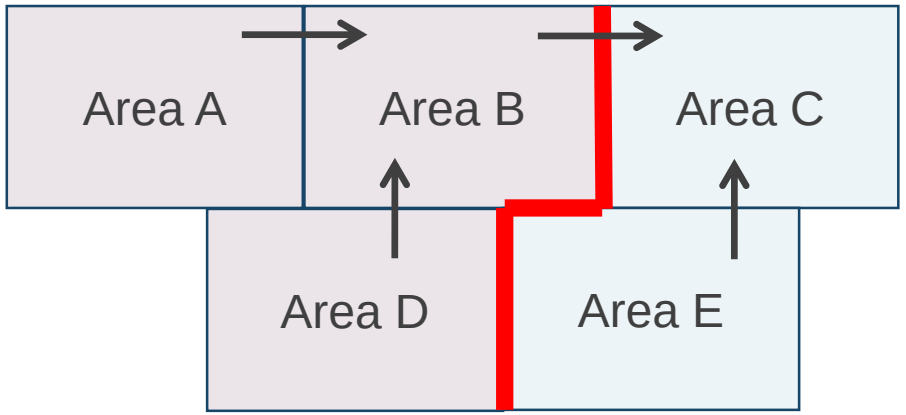
- Same principle as day-ahead market
- Easy bid setting
- Lower bid prices (marginal cost bidding vs. markup in pay-as-bid)



3. Pricing proposal (2/5)

Cross-border marginal pricing

- The AOF will compute the balancing energy price per ”uncongested area”.
- In the case there is no congestions between adjacent areas, the price will be the same in these areas.
- In case there is a congestion – there will be a price split (like the day-ahead market)
- In the case of evolving congestions, the uncongested areas for RR could be different than from mFRR; similarly, the uncongested areas for mFRR could be different from the uncongested areas for aFRR



- In this example there is a congestion on the borders B→C, B→E and D→E
- Area A, B and D have the marginal price MP1
- Area C and E have the marginal price MP2

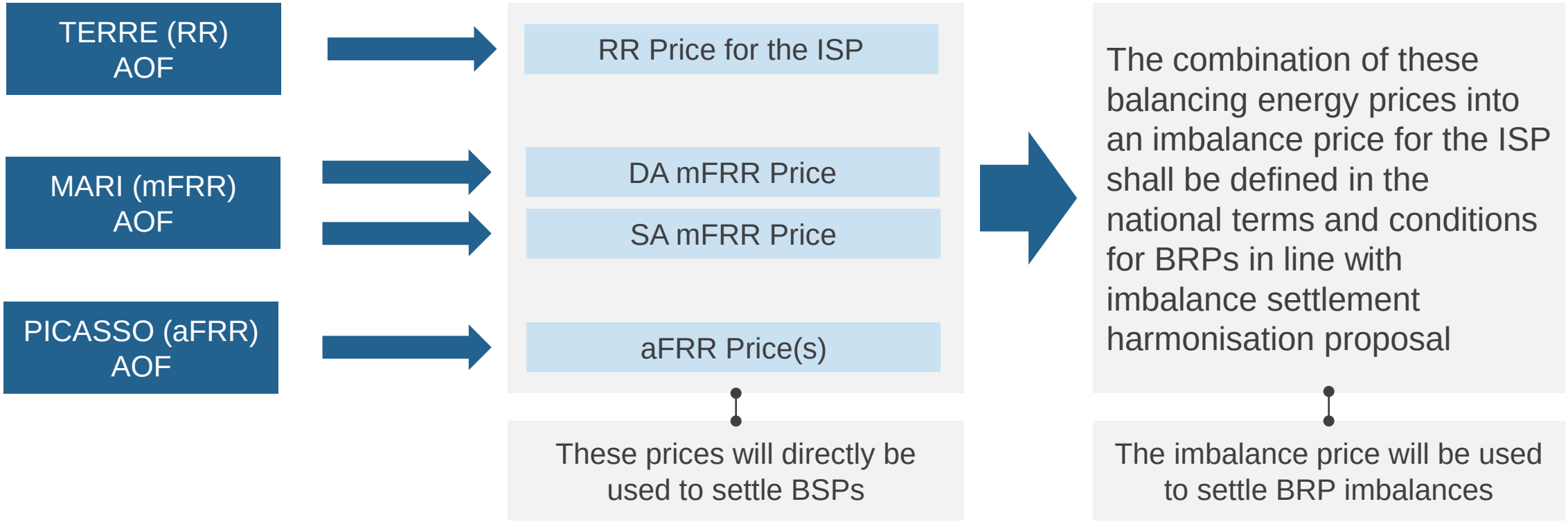
Uncongested area with marginal price = MP1

Uncongested area with marginal price = MP2

Balancing energy exhange on a border

3. Pricing proposal (3/5)

A price per product for each period, i.e. no cross-product pricing



The proposal foresees to apply different price for balancing and system constraint activation purpose (applicable in scheduled mFRR and RR).

3. Pricing proposal (4/5)

Summary of proposal (1/2)

General principles	▪ XBMP will be applied for standard product bids activated for balancing purpose ▪ One XBMP will be calculated in each platform ▪ **Each balancing energy volume will be remunerated at least with the bid price**
Application of general principles to RR and mFRR	▪ The “general principles” can be applied directly to RR and mFRR with scheduled activation. ▪ The price will be calculated by the AOF based on the result of the optimisation ▪ The article defines the intersection point which is the XBMP ▪ The balancing energy pricing period (BEPP) is 15 min, i.e. there will be one price for 15 min for scheduled mFRR and one price for 15 min for directly activated mFRR
Application of general principles to aFRR	▪ The calculation of the XBMP then follows the same principles as for RR or scheduled mFRR (but without the intricacies of the “complex” bids which are not foreseen by the implementation framework) ▪ All TSOs propose a BEPP which is equal to the optimisation cycle of the AOF

3. Pricing proposal (5/5)

Summary of proposal (2/2)

Pricing of specific products	▪ The pricing of the specific products which are converted to standard products is based on the standard product bid price (not to be confused with the pricing of bids in the central dispatch models) ▪ Bid conversion and financial neutrality of the TSO must be “taken into account” ▪ The details must be addressed at the national level
Pricing of CZC	▪ The price of the CZC will be equal to the XBMP price difference on the borders. ▪ For the energy exchange which is performed in the framework of the imbalance netting platform the CZC price will be 0 €/MWh (since the imbalance netting platform does not include a common pricing of aFRR)
Pricing of system constraints activations	▪ In the proposal – bids selected for system constraints activation purpose with a price **above** the XBMP of an optimisation with balancing-only demands **will be settled with pay-as-bid** ▪ The bids selected for system constraints activation purpose with a price **below** the XBMP of an optimisation with only balancing demands will receive the XBMP of balancing-only optimisation

3. TSO-TSO settlement proposal (1/2)

Scope	• How the settlement amounts are settled between TSOs and how the balancing congestion income is calculated and distributed among TSOs • Settlement cases: exchange of balancing energy, system constraint activations (mFRR, RR), congestion income, different prices within an uncongested area and imbalance netting
Exchange of balancing energy	• Intended exchange of balancing energy (per BEPP): settlement amounts = settlement prices (XBMP) x exchanged volumes, both calculated by the AOF

System constraint activations	• System constraints are paid by the TSOs requesting them and shall not affect the settlement amount of other TSOs. Sum of:
	  ○ volume of bid or TSO elastic demand x (MAX between bid/elastic demand price and the XBMP)
	  ○ costs resulting from non-intuitive balancing energy flows (from area more expensive to cheaper one) due to selection of bids for system constraint purposes

3. TSO-TSO settlement proposal (2/2)

Congestion income	• Calculated per border and per platform, it's the difference between a) the balancing energy volume imported x XBMP of importing area and b) the balancing energy volume exported x XBMP of exported area (i.e. difference of prices in congested areas x respective volumes)
Price difference within uncongested areas	• Price differences within an uncongested area (for mFRR or RR), due to a conflict in optimisation priorities resulting in different XBMPs: settlement = exchanged volume x (difference of XBMPs)
System of imbalance netting	• Each TSO calculates the value of avoided aFRR activations (opportunity prices) • Initial settlement price = volume-weighted average of all opportunity prices; initial settlement amounts = initial settlement price x volumes exported/imported by each TSO • Opportunity cost of each TSO = import value of opportunity cost x import amount – export value of opportunity cost x export amount • Initial rent of a TSO = opportunity cost – initial settlement amount • If negative rent for a TSO(s) but positive overall rent, the negative rent of the TSO(s) is redistributed among the ones with positive rent, so that nobody looses.

3. Imbalance settlement harmonisation (1/3)

Scope	• ISHP applies to all imbalance areas and all ISPs except for those where market activities have been suspended and the concerned TSO has received NRA approval.
Definitions	• **Single imbalance pricing**: prices for negative and positive imbalances are equal in sign and size. • **Dual imbalance pricing**: prices for negative and positive imbalances are not equal in sign and/or size.
Position, imbalance & allocated volume	• **Position** (for each scheduling unit of a BRP) is the sum of its external and internal commercial trade schedules. • The **allocated volume** (to each BRP) is the netted volume of the volumes metered connected to a TSO grid and to a DSO grid, possible corrections to third parties and residual energies. • **Imbalance** is the energy volume resulting from the difference between the allocated volume and the position.

3. Imbalance settlement harmonisation (2/3)

Imbalance adjustment (to BRPs)	• Calculated as the **netted volume** of all balancing energy volumes and volumes for purposes other than balancing **assigned to the concerned BRP**. • Additional imbalance adjustments can be done to include the energy volumes used in system defense plans (NC E&R), curtailments of schedules or other volumes associated to BRPs. • Each TSO shall inform of the imbalance adjustments to the concerned BRP.

Imbalance price calculation	• Limited amount of **components**: shall use prices, may use volumes and may use additional components.
	  ○ Price components: each TSO shall use one or more of the prices of aFRR, mFRR, RR, integrated scheduling process (CDM), value of avoided activation.
	  ○ Volume components: each TSO may only use volumes of aFRR, mFRR, RR, integrated scheduling process (CDM), imbalance netting, unintended exchanges of energy.
	  ○ Additional components: each TSO may request to its NRA the usage of a scarcity components, an incentivising component and/or a financial neutrality component.
	• An imbalance price area (delineated in each TSO's T&C for BRPs, shall be equal to one or more imbalance areas.

3. Imbalance settlement harmonisation (3/3)

Single/dual imbalance pricing	• Preference for single imbalance pricing.
	• Conditions defined for applying dual imbalance pricing.
	• Calculation of dual imbalance price:
	  ○ For aggravating imbalances: imbalance pricing based on components defined for imbalance price calculation (prices, volumes, additional).
	  ○ For non-aggravating imbalances: imbalance pricing either following the calculation of the VoAA or following the methodology defined nationally for single imbalance pricing.

Value of avoided activation	• VoAA of balancing energy from FRR or RR, in the event that no activation of balancing energy in either direction has occurred during the ISP, is the reference price to be considered for setting the boundary conditions to imbalance prices and for non-aggravating imbalances. • For dual imbalance pricing, the TSO may calculate two VoAAs (one per direction) for each ISP during which there has been no activation of balancing energy in either direction. • For the calculation of the VoAA, each TSO may only use the prices of aFRR, mFRR, RR, integrated scheduling process.

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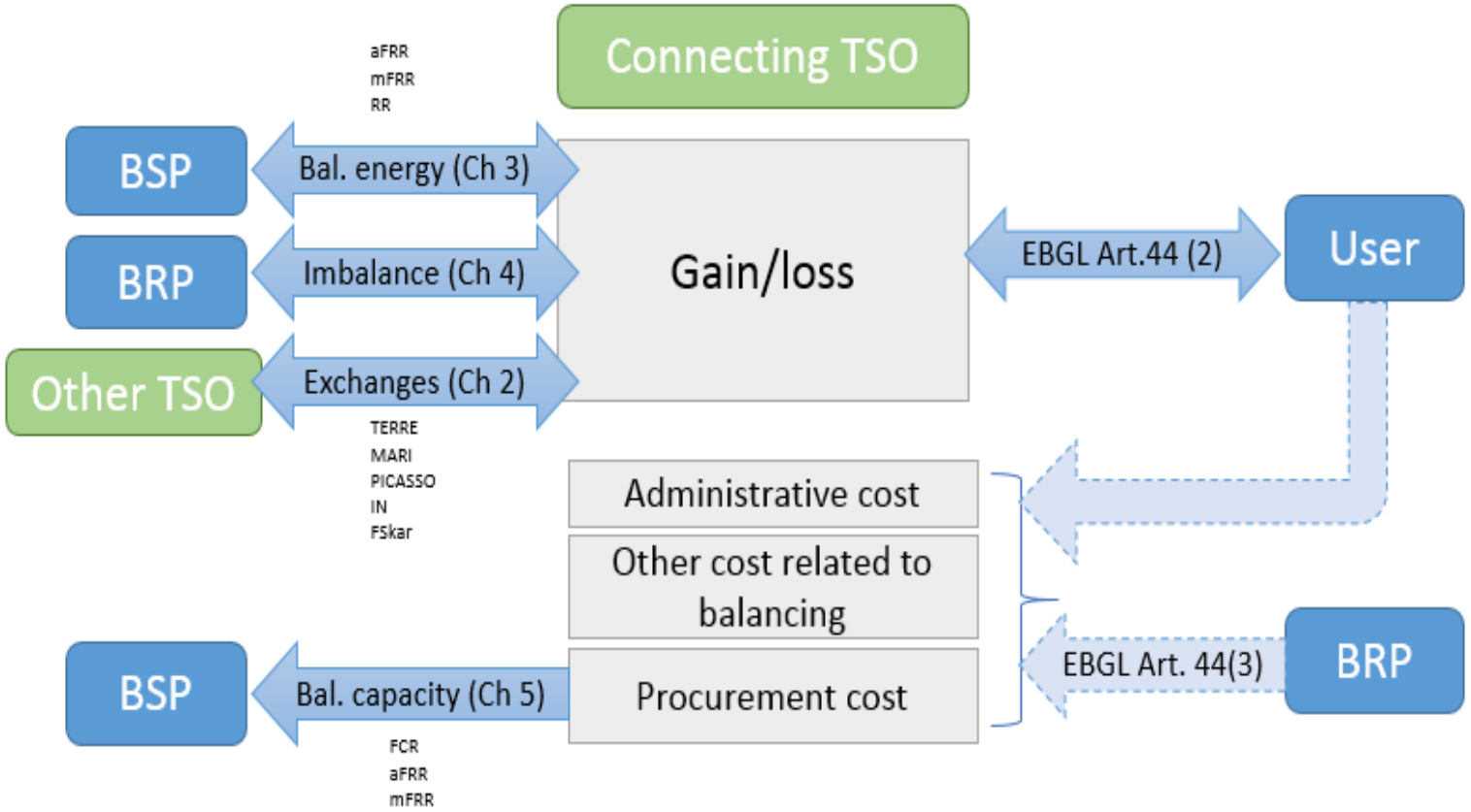
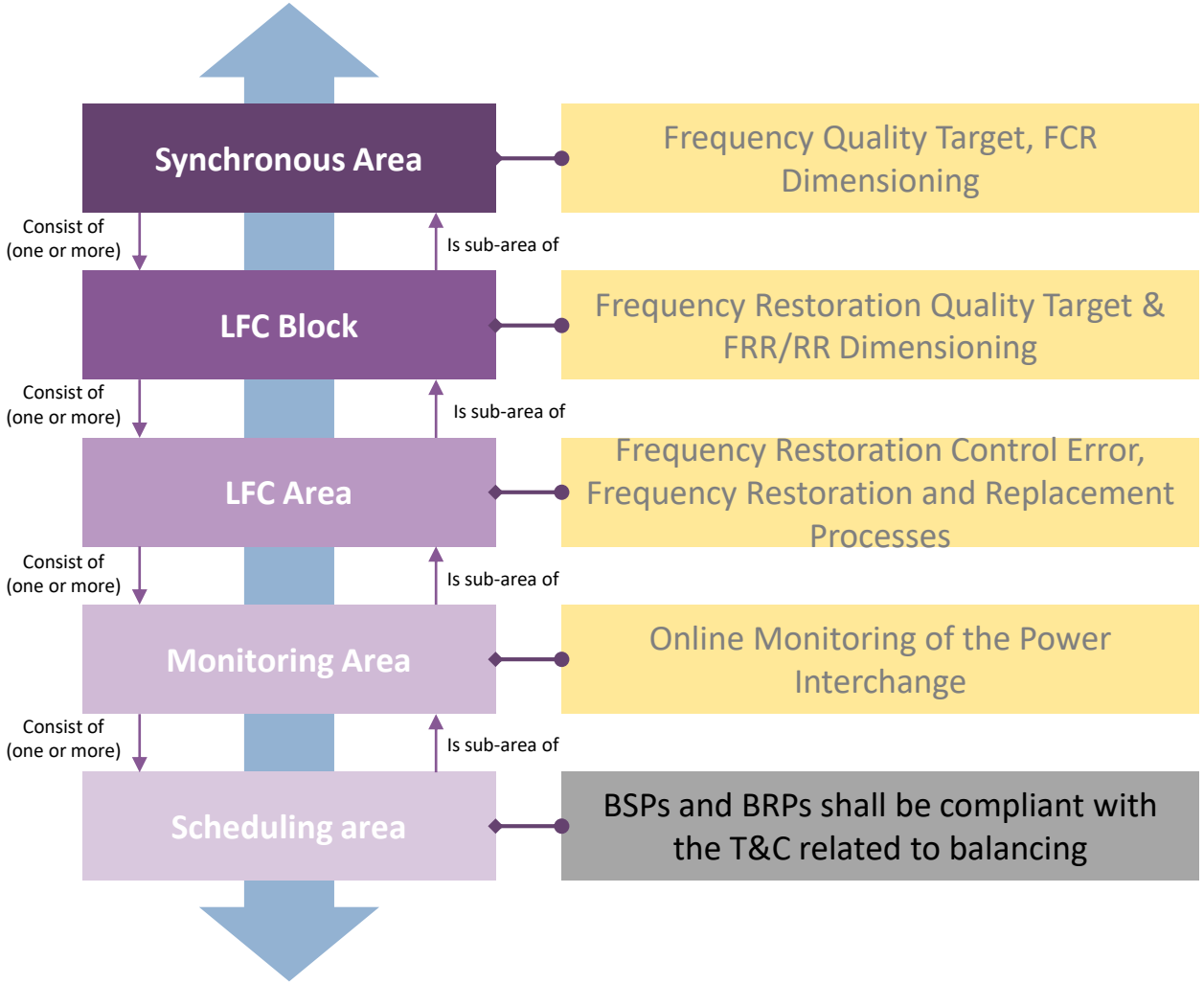
(Backup slides)

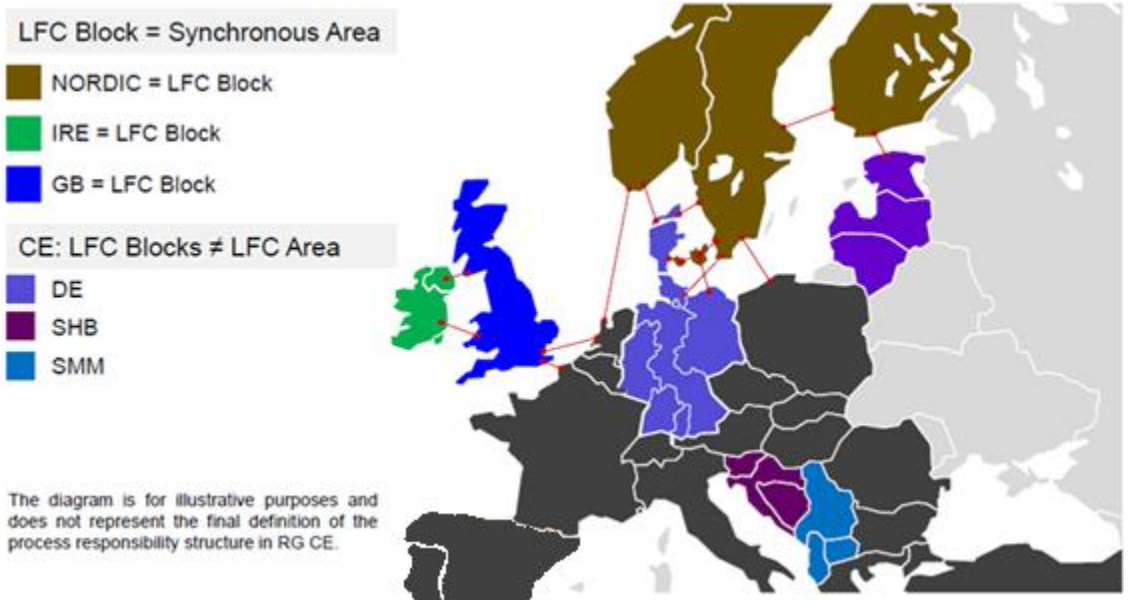
1. Market participants involved (2/2)

Clash flows between participants



1. Balancing operational areas

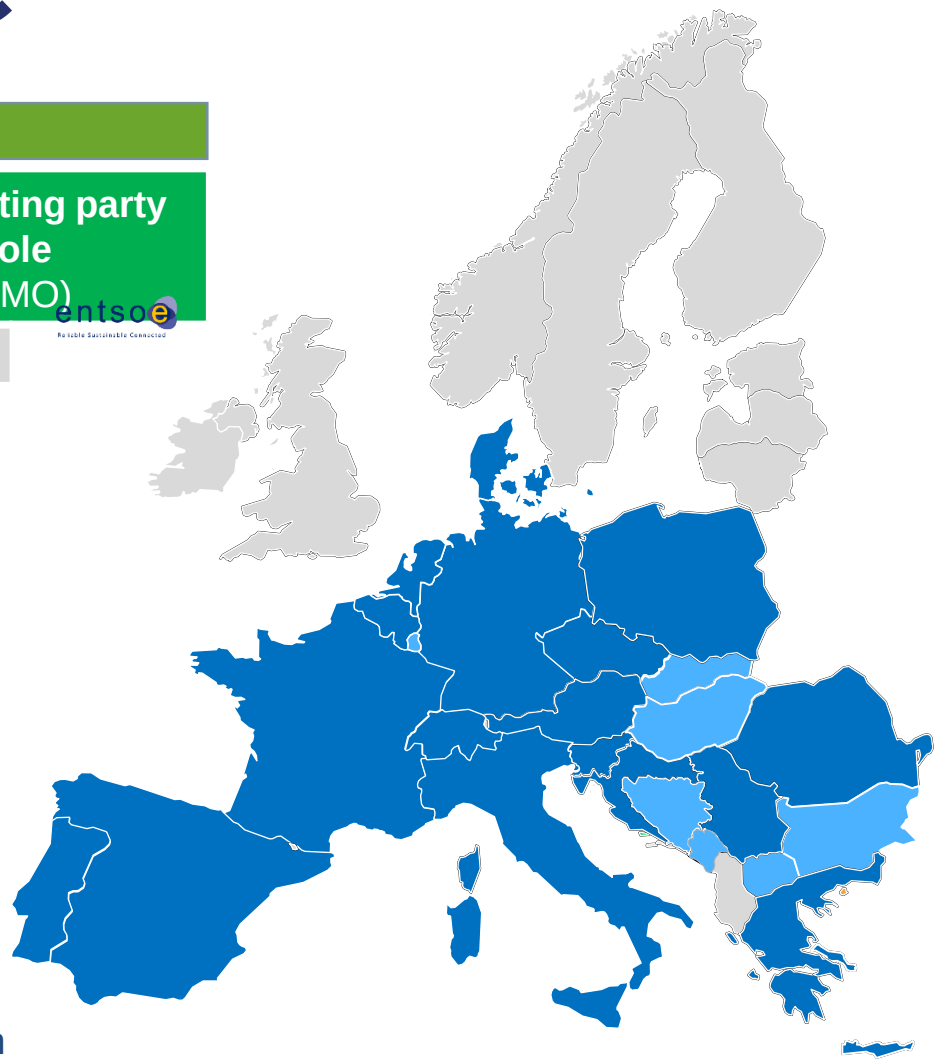




2. Imbalance netting - IGCC

27 TSOs + ENTSOE (Facilitator)

IGCC Member TSOs (9 non-operational TSOs)	IGCC Participating TSOs (11 operational TSOs)	IGCC observers (7 TSOs)	Facilitating party role (PMO)
Croatia	Austria	Bosnia and Herzegovina	ENTSO-E
Greece	Belgium	Bulgaria	
Italy	Czech Republic	Hungary	
Poland	Denmark	Luxembourg	
Portugal	Germany	Montenegro	
Romania	France	North Macedonia	
Serbia	The Netherlands	Slovakia	
Slovenia	Switzerland		
Spain			



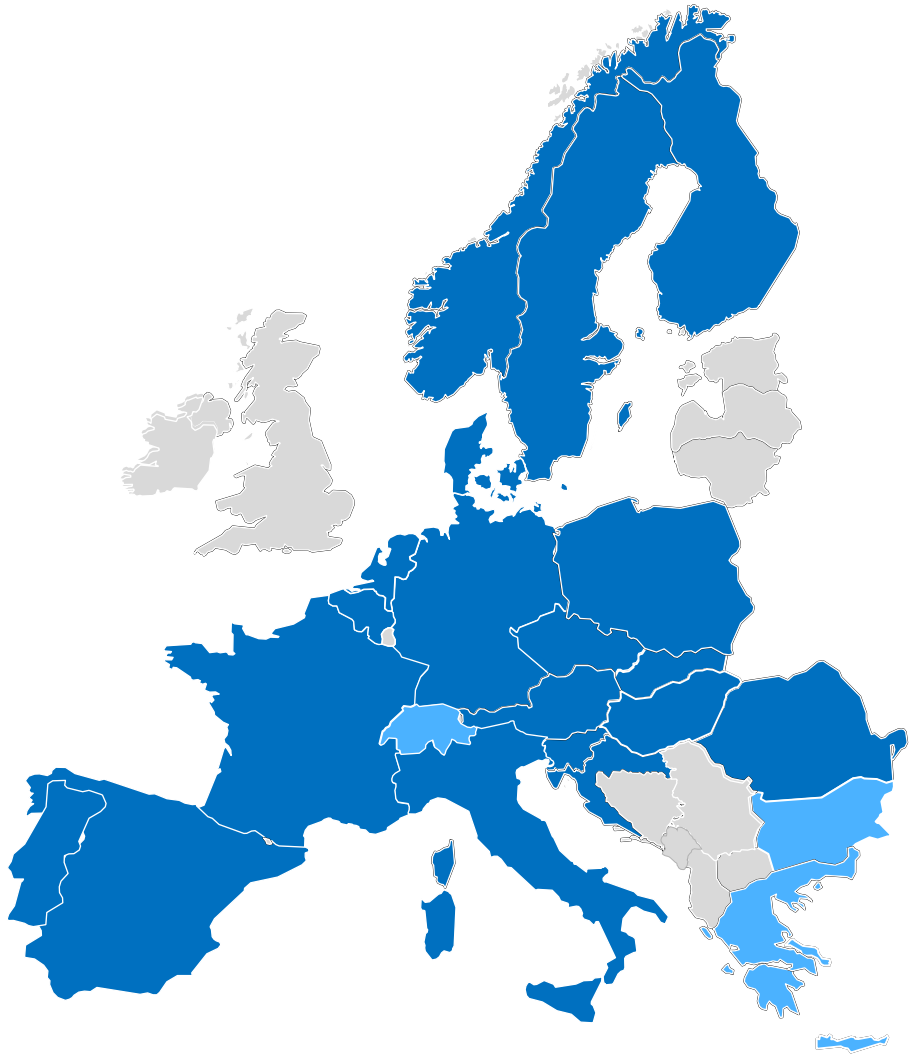
- ENTSO-E balancing implementation project since **11 February 2016**.
- **ENTSO-E** fulfils the facilitating party role (PMO).

IGCC Member IGCC Observer

2. aFRR - PICASSO

25 TSOs + ENTSOE

PICASSO members (22 TSOs)				PICASSO observers (3 TSOs + ENTSO-E)	
Austria	APG	Poland	PSE	Bulgaria	
Belgium	elia	Portugal	REN	Greece	ΑΔΜΗΕ
Croatia	HOPS	Romania		Switzerland	swissgrid
Czech Republic	ČEPS, a.s.	Slovakia	SEPS	ENTSO-E	entsoe
Denmark	ENERGINET	Slovenia	ELES		
Finland	FINGRID	Spain	RED ELECTRICA DE ESPAÑA		
France	Rte	Sweden	SVENSKA KRAFTNÄT		
Germany	50hertz, TRANSNETBW, TenneT, amprion				
Hungary	MAVIR				
Italy	Terna Rete Italia				
The Netherlands	TenneT				
Norway	Statnett				



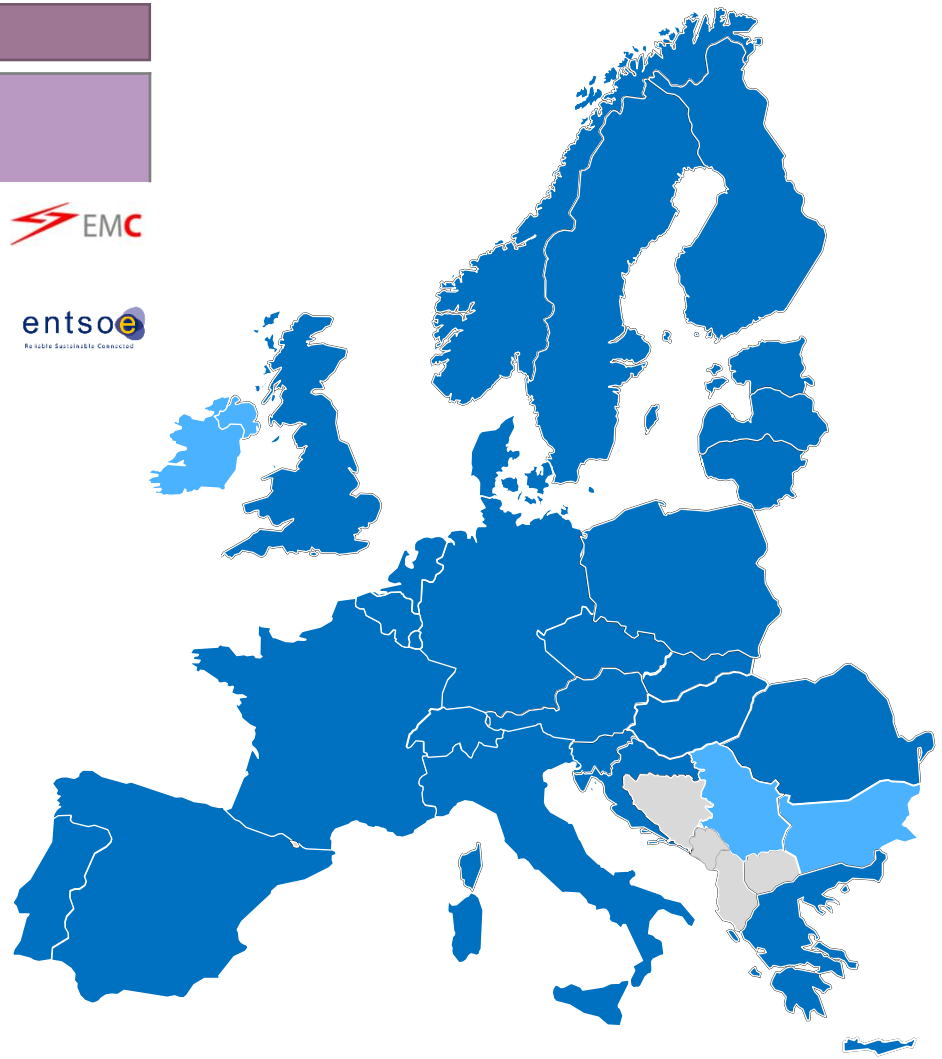
- ENTSO-E balancing implementation project since **9 November 2017**.

2. mFRR - MARI

32 TSOs + ENTSOE

MARI members (28 TSOs)		MARI members (28 TSOs)	
Austria	APG	Italy	Terna Rete Italia
Belgium	elia	Latvia	AST
Croatia	HOPS	Lithuania	Litgrid
Czech Republic	ČEPS	Norway	Statnett
Denmark	ENERGINET	Netherlands	TenneT
Estonia	elering	Portugal	REN
Finland	FINGRID	Poland	PSE
France	Rte	Romania	Transelectrica
Hungary	MAVIR	Slovenia	ELES
Germany	50hertz, TenneT, amprion, TRANSNETBW	Slovak Republic	SEPS
Greece	ΑΔΜΗΕ	Spain	RED ELÉCTRICA DE ESPAÑA
		Sweden	SVENSKA KRAFTNÄT
		Switzerland	swissgrid
		United Kingdom	nationalgrid

MARI observers (4 TSOs + ENTSO-E)		MARI observers (4 TSOs + ENTSO-E)	
Bulgaria		Serbia	EMC
Ireland Northern Ireland	EirGrid, SONI	ENTSO-E	entsoe



- ENTSO-E balancing implementation project since **7 September 2017**.

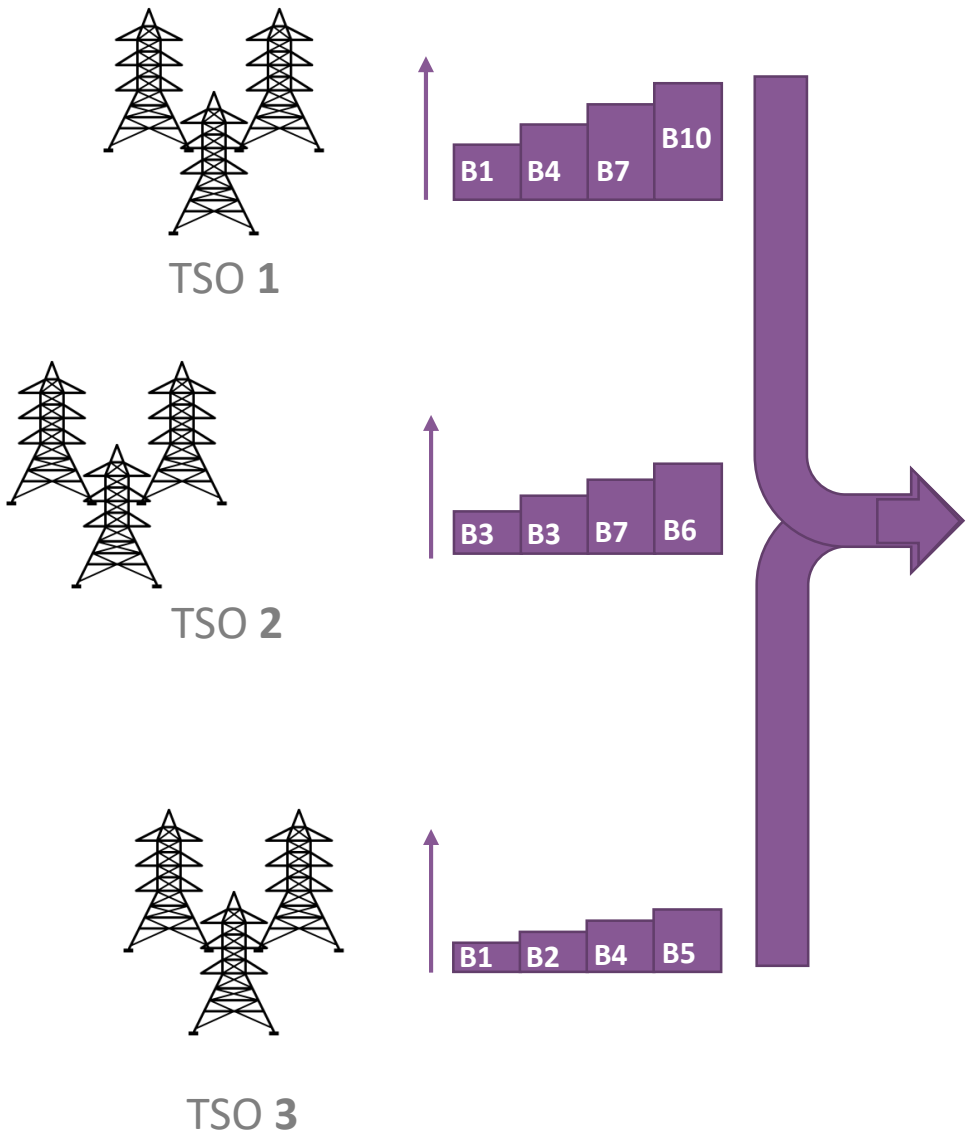
2. Replacement reserves - TERRE

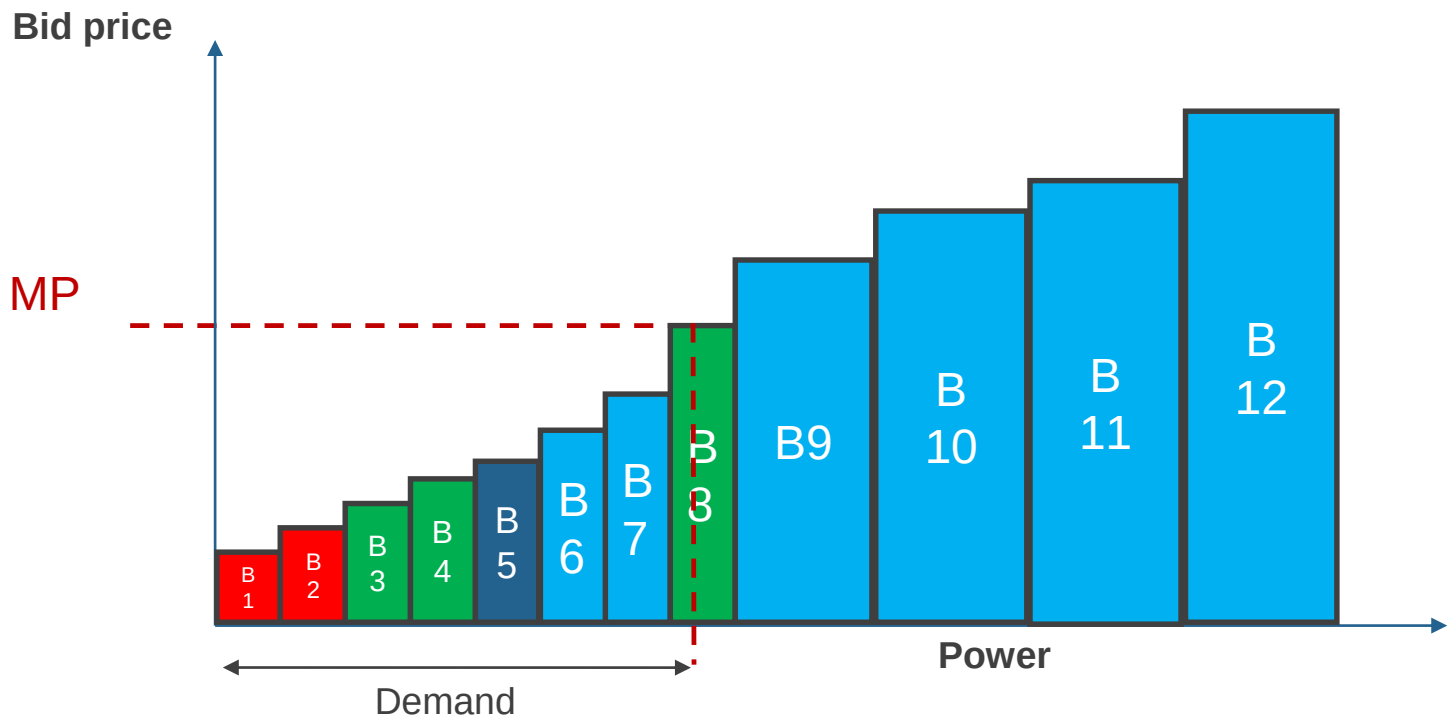
TERRE members (6 TSOs)
France
Great Britain
Italy
Portugal
Spain
Switzerland

TERRE Observers
ADMIE
Bulgaria
Czech Republic
Hungary
Norway
Poland
Romania
ENTSO-E

- Confirmed by ENTSO-E as the RR implementation project on **27 Oct. 2016**.
- ČEPS, Transelectrica and PSE and will become full members early 2019.

3. Bids, demand: CMOL and pricing





3. Bids, demand: CMOL and pricing

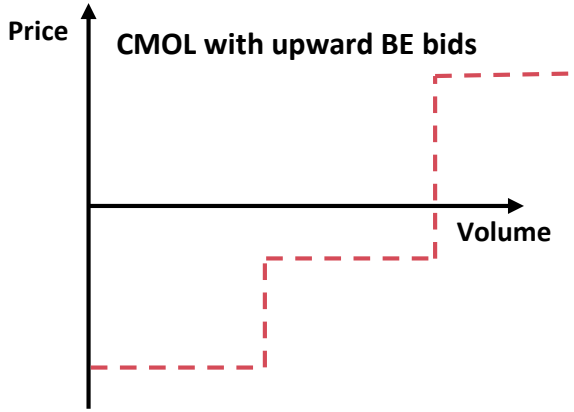


Figure 1. **Downward demand (Negative imbalance demands)**

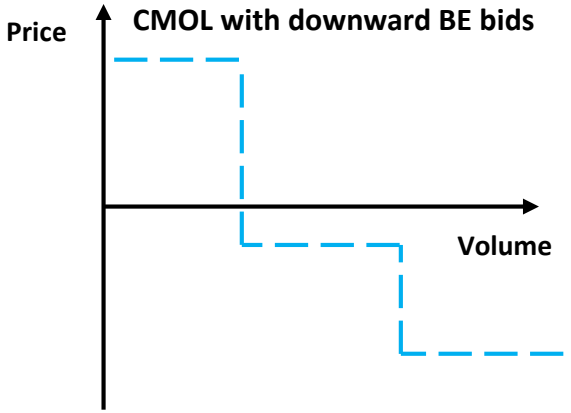
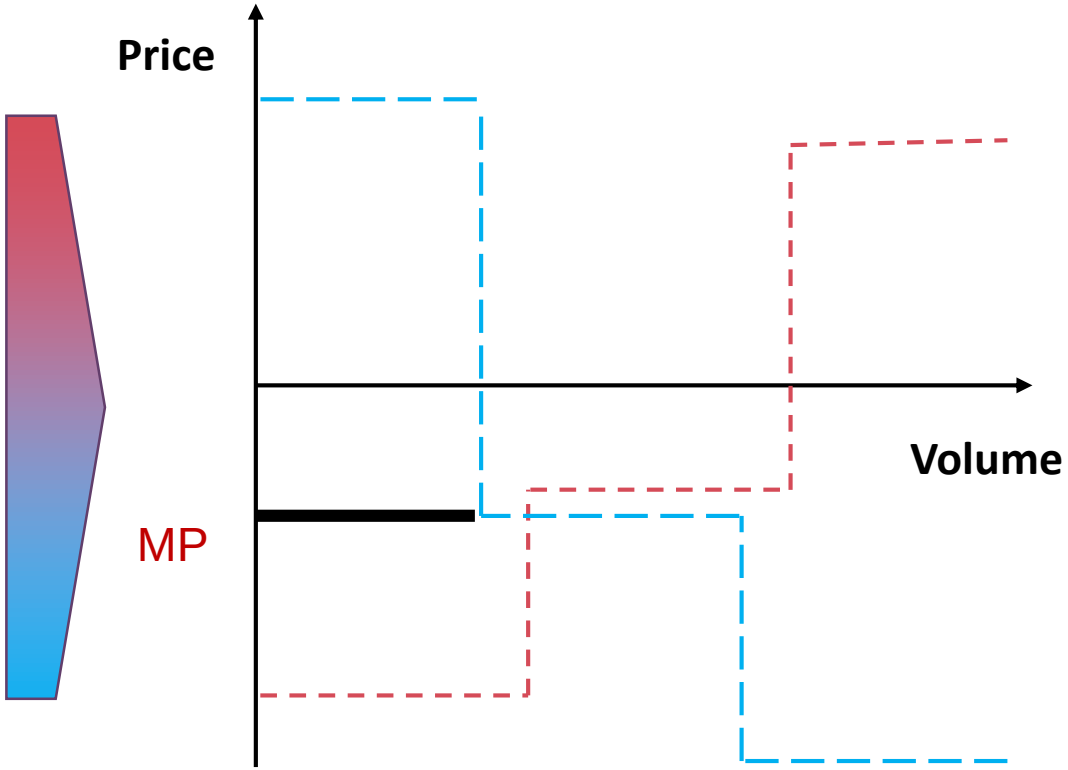


Figure 2. **Upward demand (Positive imbalance demands)**

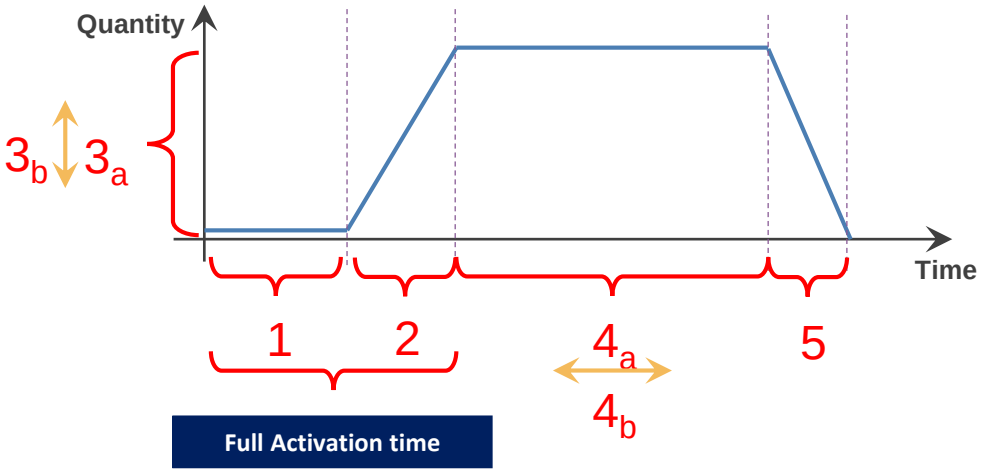
Upward regulation price → BSPs sales price of balancing power
→ TSOs purchase electricity to the market players



Downward regulation price → BRPs purchase price of balancing power
→ TSOs sales electricity to the market players

3: Standard products - fixed characteristics

Fixed characteristics of the standard balancing energy product bids



	aFRR	mFRR	RR
Mode of activation	Automatic	Manual	Manual and scheduled
Activation type		Direct or scheduled	
1- Preparation period	-		From 0 to 30 min
2- Ramping period	-		From 0 to 30 min
1+2- Full Activation time	5 minutes (as of 18 Dec 2025)	12.5 minutes	30min
6- Deactivation period	No longer than FAT		Under national responsibility
3_b- Min quantity	1 MW	1 MW	1MW
Bid granularity	1 MW	1 MW	
3_a- Max quantity	9,999 MW	9,999 MW	In case of divisible bid, no max is requested only technical limit (IT limit). In case of indivisible bid, national rules will be implemented
4_b- Min delivery period	No minimum delivery time shall be permitted.	5 minutes	15min
4_a- Max delivery period			60 min
Validity period	15 minutes The first validity period of each day shall begin at 00:00. The validity periods shall be consecutive and not overlapping.	A scheduled activation can take place at the point of scheduled activation only. A direct activation can take place anytime during the 15 minutes after the point of scheduled activation.	Defined by BSP and respecting the min and max delivery period

3. Standard products - variable characteristics

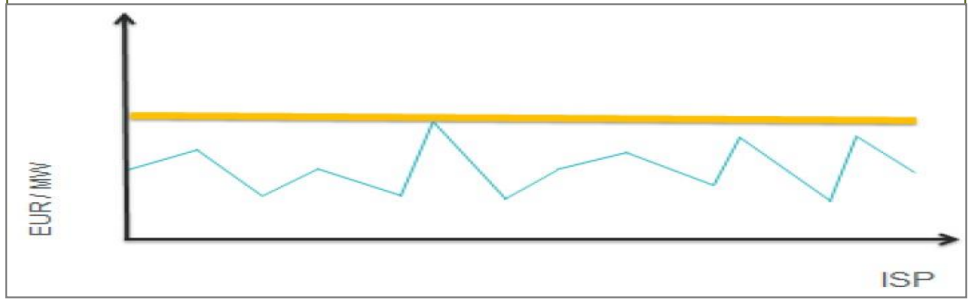
Variable characteristics of the standard balancing energy product bids	aFRR	mFRR	RR
Price	Defined by BSPs in €/MWh	Defined by BSPs in €/MWh	Defined by BSPs in €/MWh
Price resolution	0.01 €/MWh	0.01 €/MWh	
Location	The scheduling area and the connecting TSO to which the aFRR providing units and/or groups shall deliver the aFRR standard balancing energy.	At least the smallest of LFC area or bidding zone. More detailed locational information under national responsibility	Bidding zones
Divisibility	Divisible - the activation request can be lower than the minimum quantity and minimum granularity. can be activated and deactivated at any moment within the validity period	The BSPs are allowed to submit divisible as well as indivisible bids. Divisible bids have an activation granularity of 1 MW	Divisible and/or indivisible bids allowed (Resolution for divisible bids = 0.1 MW)
Technical links between bids	The connecting TSO may include the possibility to link the bids to the state of activation of reserves from another balancing process in accordance with the National Terms and Conditions.	Due to the existence of direct activations, BSPs are required to provide information on mutual exclusivity of bids submitted in consecutive quarter hours.	
Economic link		Child with parent and exclusive group orders will be allowed, unless these features add decisively for the complexity of the algorithm.	

Balancing Energy Pricing Period for aFRR

2 approaches

- Balancing energy pricing period (**BEPP**): time interval for which XBMPs are calculated

Optimisation-cycle BEPP	15-minute BEPP
• The XBMP is determined on an optimisation-cycle basis (e.g. each 4 s) • The imbalance price is based on a volume-weighted average	• The XBMP is determined on an ISP basis (each 15 minutes) • The imbalance price is directly based on XBMP



- Note:
  - The aFRR activations are unchanged.
  - The aFRR balancing energy price(s) resulting from the 2 approaches contribute differently to the imbalance settlement price.

Optimisation cycle BEPP - description

- For each run of the activation optimisation function (AOF), a different price is set. All balancing energy bids activated during one optimisation cycle receive the same price.
- Each BSP will receive a weighted average balancing energy settlement price for every activated bid per ISP. This means multiple balancing energy prices per ISP.
- The price is directly derived from the algorithm and consider the TSO demand and the congestions that occur during this run
  - Uncongested area between TSOs may change at each optimisation cycle
- Imbalance price for a given ISP could be an average of all the optimisation cycle prices over this ISP.

Pros & cons of optimisation-cycle BEPP

Pros optimisation-cycle BEPP

- Provides a **full consistency** with the AOF results (bid selection, congestion, prices)
- **Maximises** the occurrence of **price convergence between LFC areas**, thus, maximises the competition among the BSPs.
  - This is seen as a critical element for markets with limited internal competition in order to efficiently apply a marginal pricing approach.
- It is **simple** and **transparent** from an algorithmic perspective.
- Avoids cases where the congestion rent is artificially increased, and cases where the congestion rent is negative.

Cons optimisation-cycle BEPP

- Does **not** provide a **full consistency** between settlement period for **BRPs (ISP)** and BSPs (BEPP), where ISP is equal to 15 minutes.
- Entails more complexity in terms of **data handling**.

15-minute BEPP - description

- One single price per direction is selected for each ISP for each uncongested area (assuming activation in that direction): the highest/lowest activated bid price in the upward/downward direction per uncongested area.
    - In case of aFRR activations in the uncongested area in both upward and downward directions within the same ISP, two prices will be determined for the ISP.
- The XBMP is determined for each full ISP: when congestions occur at any point within the ISP, price divergence will apply for the full ISP.
- Uncongested areas are defined on ISP-basis.

Pros and cons 15-min BEPP

Pros 15-min BEPP

- The aFRR component of imbalance price can be set directly equal to the aFRR balancing energy price
  - Where the ISP is equal to 15 minutes and when no other balancing product is activated, it provides a full consistency between balancing energy prices and imbalance prices
- Less data handling than optimisation-cycle BEPP

Cons 15-min BEPP

- Discrepancy between the congestion considered in the AOF for the activation and the congestions that are considered to derive the 15-minute prices
- The congestion rent has to be calculated separately in each direction with separate prices for upward and downward activations. Congestion rent for 15-min BEPP is expected to be generally higher than the congestion rent for control-cycle BEPP (due to more congestions), but there are specific cases where it can be negative

Potential effect on the bid prices

Two effects on the bid price have been identified related to the choice of the BEPP:

- If the **BEPP** is **15 minutes**, a discrepancy is introduced between the “activation”-congestions (established every optimisation cycle) and the “price”-congestions (15 minutes)
  - The “price”-congestion will be the (combination of the) most congested situation of all the optimisation cycles
    - If a border is congested during one optimisation cycle, it will be considered “price”-congested for the whole quarter
  - This discrepancy can lead to bidding strategy where increasing the bid price leads to more benefits for a BSP even if there are less activations
    - This would not be in line with the fundamentals of a marginal pricing approach where the bidding at marginal cost would theoretically be the most efficient bidding strategy
    - The bidding strategy could be derived by a statistical analysis of past results, considering the (medium-term) benefits obtained under different bidding strategies
    - This problem of discrepancy between “activation”-congestions and the “price”-congestions is more acute when the occurrence of congestions has more influence on the competition between BSPs. Typically: small areas, with little internal competition

Potential effect on the bid prices

- If the **BEPP** is equal to the **optimisation-cycle**:
  - The BSPs may include a mark-up in its bid price because the self-regulating effect of BRP costs on the BSP price would be less present due to an averaging effect of the BSP settlement price in the imbalance price over the ISP length
    - *In other words: the BSPs would not be incentivised to bid in at reasonable costs in order not to increase too much their costs as a BRP*.
  - The BSPs may increase the bid price at the beginning of the merit-order since the benefits may be less than what can be captured by playing on the imbalance position (where this is allowed)
  - For the BSPs at the end of the merit order, there may be a disincentive to deliver (depending on penalty regime, and on imbalance pricing approach)

As there are theoretical considerations that can justify including mark-ups in the bid price for both the BEPP of 15 minutes and the BEPP equal to the optimisation cycle, it is not possible to draw definitive conclusions on the effect of the BEPP choice on the bid price.

The choice of the BEPP has consequently been based on the other pros and cons.

Price divergence

UAB rule and link with pricing - Example

Let's imagine 1 area with an inelastic positive need and 3 offers: 1 IUB, 1 DUB and 1 DDB as illustrated on the picture.

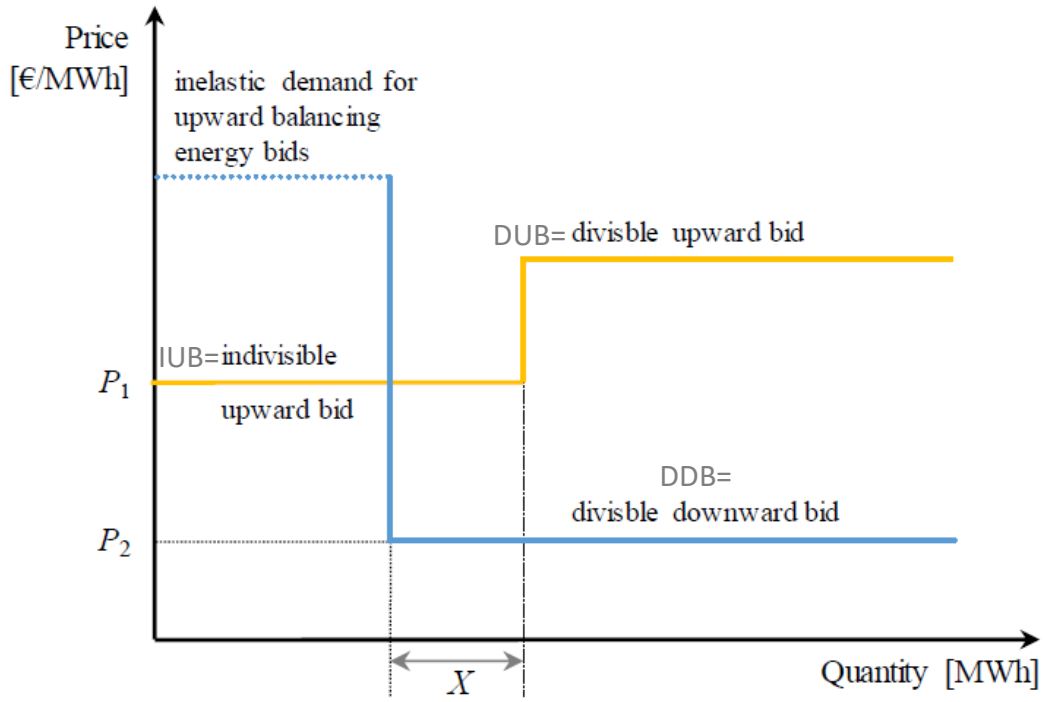
Because the first upward bid is indivisible, there are two ways to satisfy the inelastic demand:

- **Option 1: we accept the IUB as well as a part of DDB.**

We could either put the marginal price at P1 or P2. In both cases, we either have IUB or DDB that are paradoxically accepted.

- **Option 2: we reject offer IUB and we accept a part of DUB.**

In this case, we set the marginal price at DUB price. We have no paradoxically accepted bid.



UAB rule and link with pricing - options

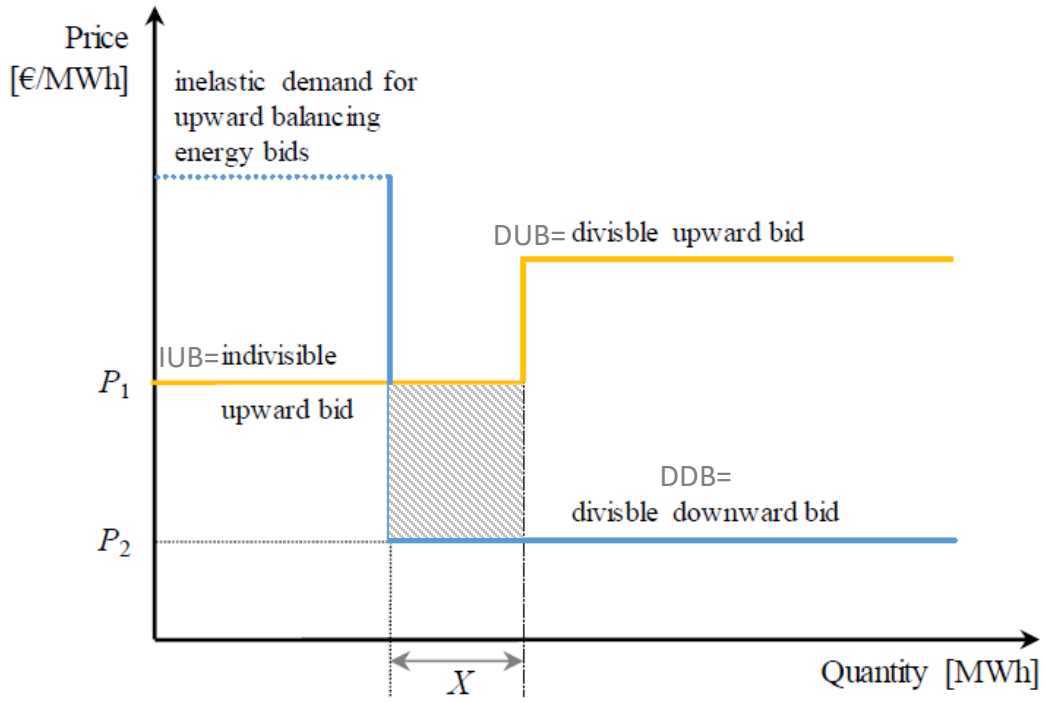
Thus, following the previous example, there are two UAB pricing rules:

We accept UAB (***option 1*** from previous example).

In such case, the marginal price does not comply with the rules that the bids have to be remunerated at least their bid price, at least for one bid. A side payment is needed for IUB and/or DDB offer to respect this rule. The cost of this side payment corresponds to the area is done at TSO level, further referred to as "missing money".

We reject UAB (***option 2*** from previous example).

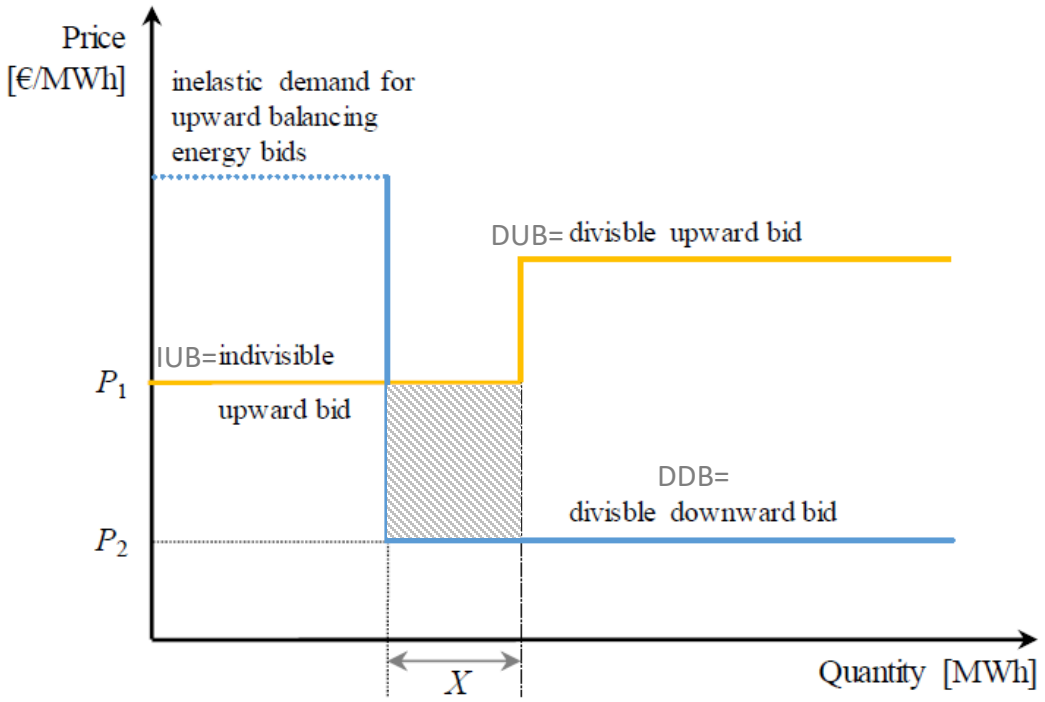
UAB can be rejected thanks to an appropriate set of constraints in the algorithm. The marginal price (price of DUB in the example) is then consistently used in all settlement processes. There is no problem of missing money.



UAB options pros and cons

	PROS	CONS
Accept UAB (side payments)	• Higher social welfare • Less complex algorithm	• A more complex settlement process is needed for the missing money • Different prices for balancing purpose (meaning prices of UAB offers do not set the MP)
Reject UAB (single MP)	• Unique price for balancing purpose • No mechanism is needed for the missing money	• Lower social welfare • More complex algorithm

Zoom on the acceptation of UAB



1. A rule to set the XBMP has to be defined:
   - Idea 1: intersection point
   - Idea 2: mid-point computation
   - Other approaches can be found

2. A mechanism to finance the missing money ▨ has to be found
   - Idea 1: the side-payment is paid by the connecting TSO without compensation mechanism
   - Idea 2: the missing money is financed through a common funding as integral part of the TSO-TSO settlement
     - Example 2a: a share of the congestion rent is used for this purpose
     - Example 2b: a share of the surplus arising from the netting of TSO demand is used for this purpose

- Other approaches likely possible

Zoom on the rejection of UAB

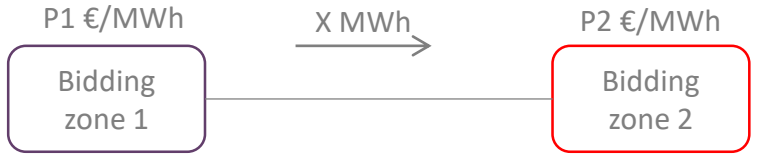
The UAB rule interferes with other market rules, like price convergence rule. In some situations, we need to decide which rule has priority.

In those situations, in order to satisfy an inelastic demand while guaranteeing UAB rejection, the prices of two bidding zones is allowed to diverge even without any congestion between those bidding zones.

This is called **price divergence**:

Different prices within an uncongested area

(this never happens inside the same bidding zone)



Always from the ***cheapest to the most expensive area*** → P1 < P2

An income is generated on this line which has to be shared

➢ **This case is theoretically identified but likelihood is likely low** (see example on next slide). Occurrences will be measured with tests on real datasets.

Zoom on the rejection of UAB rule
Price divergence - theoretical example

Available bids for Zone A:

IUB-A: indivisible upward bid of 30 MW @ 40 €/MWh

IDB-A: indivisible downward bid of 20 MW @ 60 €/MWh

Available demands and bids for zone B:

IUD-B: inelastic upward need of 20 MW @ 100 €/MWh (assumed market cap)

DUB-B: divisible upward bid of 10 MW @ 80 €/MWh

All bids are accepted and the inelastic demand is satisfied.

The price is 60 €/MWh in zone A and 80 €/MWh in zone B.