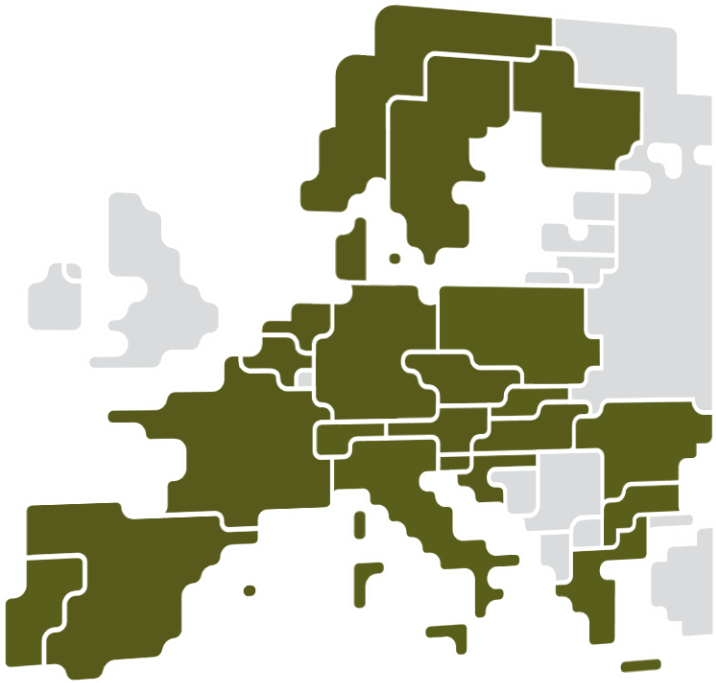
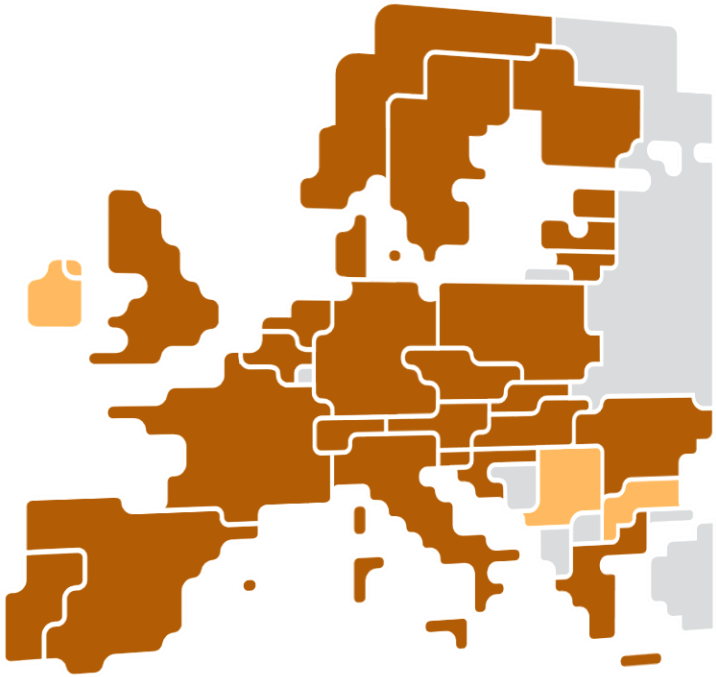
PICASSO
MARI

Stakeholder Workshop
13 July 2020 (webinar session)



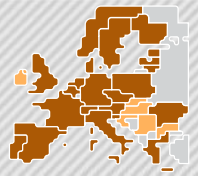


Workshop on MARI and PICASSO implementation

AGENDA

No.	Subject	Duration
1.	***Welcome:*** - Welcome to participants - Agenda	**9:30 - 9:40**
2.	***MARI*** - The mFRR process - mFRR balancing energy product - mFRR bidding design (linked, indivisible, parent-child bids; bid parameters) - Activation optimisation function (AOF) of mFRR-Platform - Pricing principles - MARI's TSO accession roadmap and Covid-19 impacts - Project timeline Q&A	**9:40 - 12:00**
	Lunch	**12:00 – 13:30**
3.	***PICASSO*** - The aFRR process - aFRR balancing energy product - Activation optimisation function (AOF) of aFRR-Platform - Pricing principles - PICASSO's TSO accession roadmap and Covid-19 impacts - Project timeline Q&A	**13:30 – 16:00**
4.	***General (common for MARI and PICASSO)*** - Balancing energy gate closure time (BE GCT): timing for bid submission - Monitoring and reporting Q&A	**16:00 - 16:50**
5.	***AOB***	**16:50 - 17:00**

Practical information



Physical attendance

- Due to COVID-19 restrictions, the stakeholder workshop is a webinar only

Online attendance

- All conference participants should mute themselves (and are muted otherwise) to avoid disturbance
- Questions and answers can be provided in the chat function, which is only available when joining the conference on a computer
- Q&A are to be sent to the participant ‘Questions & Answers’

General

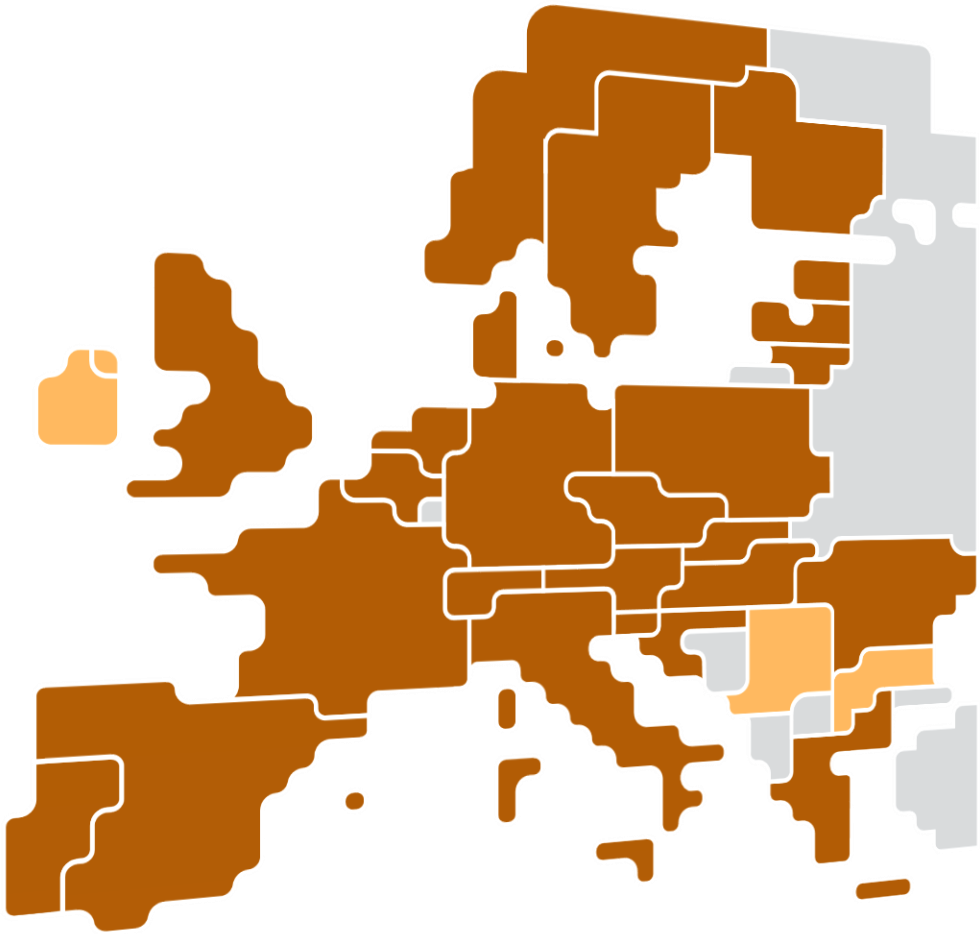
- Questions and answers that cannot be answered during the conference will be answered afterwards
- Lunch will be at 12:00 and coffee at 16:00
    - During lunch, the webinar will remain open

1. Welcome and introduction

Agenda

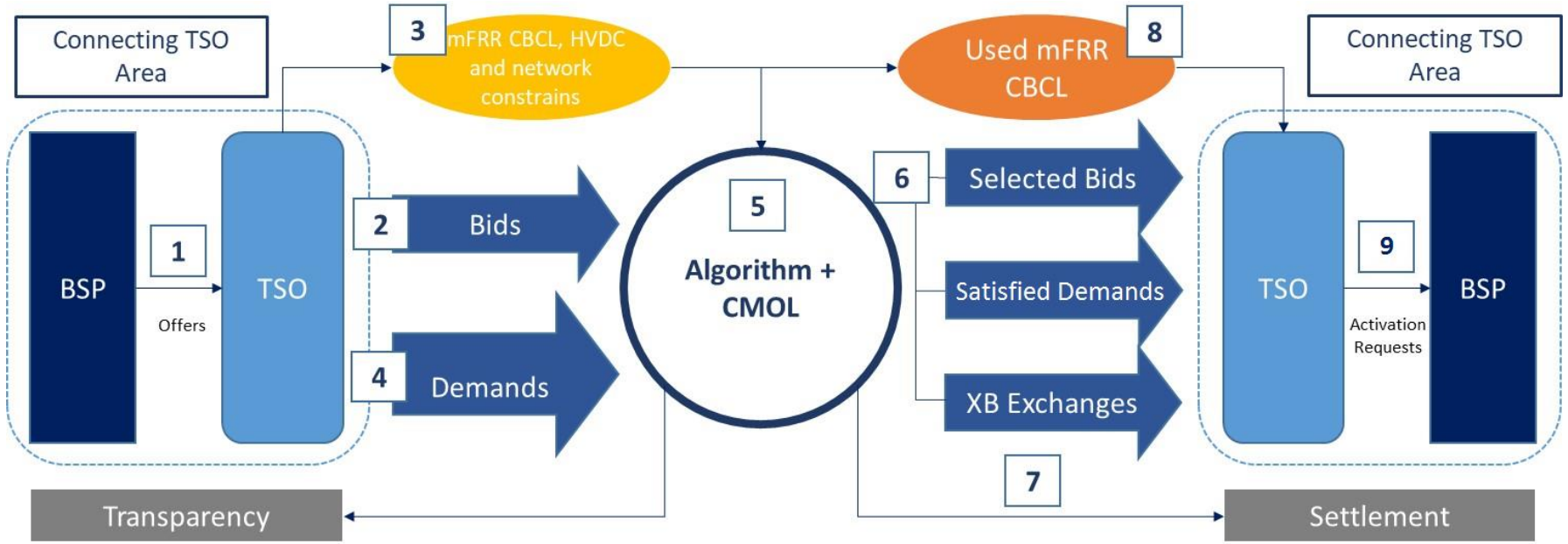
	SUBJECT	WHO	TIMING
1	**Welcome & Introduction**		
2	**mFRR Process**		
3	**mFRR Balancing Energy Product**		
4	**MARI Bidding design**		
5	**MARI Algorithm (AOF)**		
6	**mFRR Pricing**		
7	**MARI Project timing**		
8	**Closure**		

mFRR Process



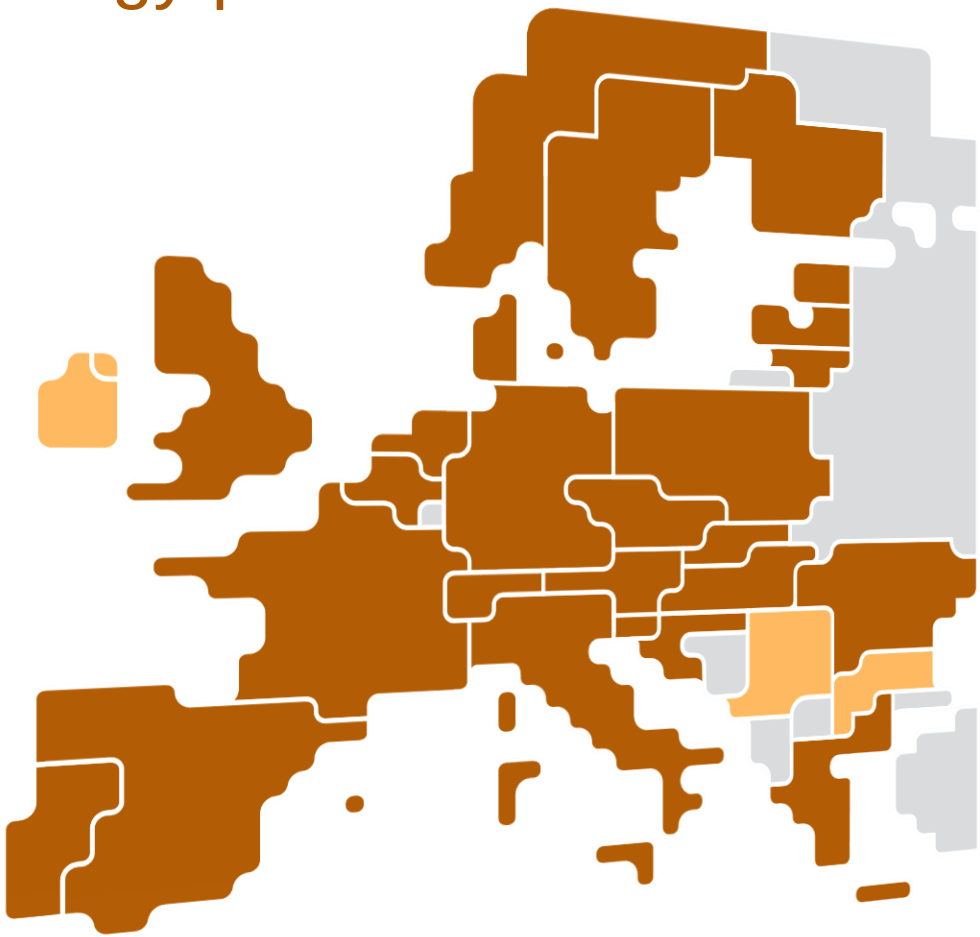
The mFRR process

General Process of mFRR Activation



1. TSOs receive bids from BSPs in their imbalance area
2. TSOs forward standard mFRR balancing energy product bids to the mFRR Platform
3. TSOs communicate the available mFRR cross border capacity limits (CBCL) and any other relevant network constraints as well HVDC constraints
4. TSOs communicate their mFRR balancing energy demands
5. Optimization of the clearing of mFRR balancing energy demands against BSPs' bids
6. Communication of the accepted bids, satisfied demands and prices to the local TSOs as well as the resulting XB exchanges
7. Calculation of the commercial flows between imbalance areas and settlement of the expenditure and revenues between TSOs
8. Remaining mFRR CBCL are sent to the TSOs
9. TSOs send activation requests to BSPs in their imbalance area

mFRR Balancing energy product



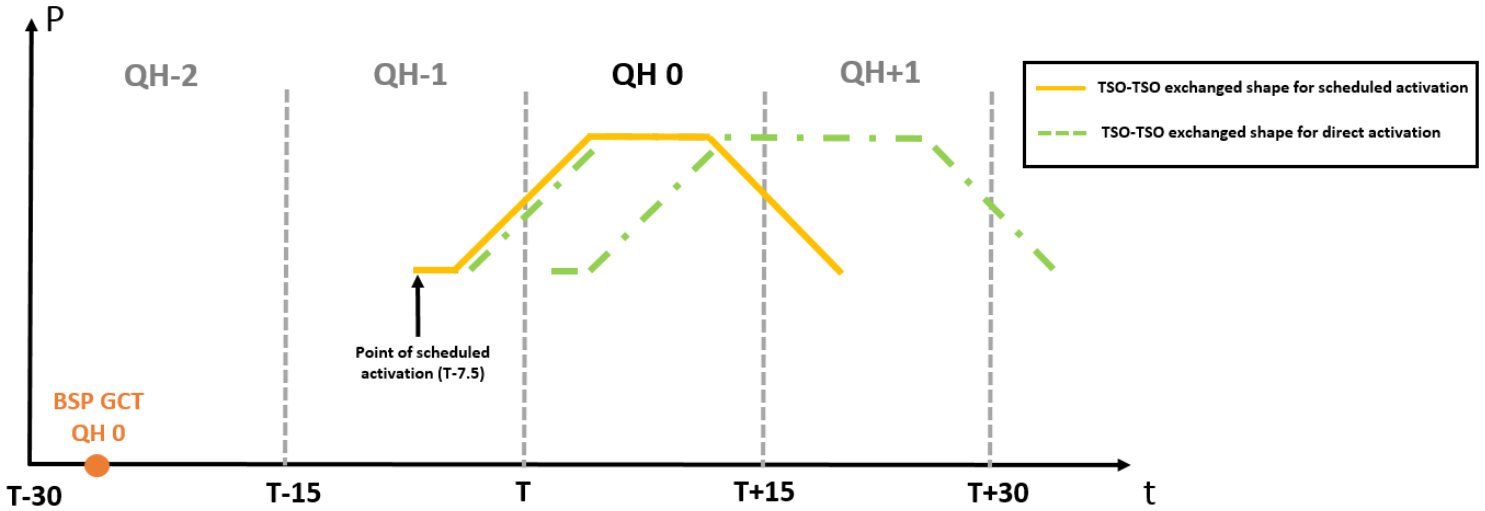
mFRR Balancing Energy Product

Standard mFRR Product

- The standard mFRR product can be ordered either through ***Scheduled Activation*** **or** ***Direct Activation*** with minimum quantity 1 MW.
- BSP's **may choose** if their bids are available **for *Direct Activation***.
- The **Full Activation Time** is the **same for both** Scheduled Activation and Direction Activation (12,5 minutes).

- *Scheduled Activation* will be **run every 15 minutes**, once for each quarter hour throughout the day, with delivery for the next full quarter hour.
- TSO – TSO delivery shape*:
  - 12.5 minutes Full Activation Time, consisting of
    - 2.5 minutes preparation time (from T-7.5 to T-5)
    - 10 minutes start ramping (T-5 to T+5)
  - **5 minutes full delivery (from T+5 to T+10)**
  - 10 minutes end ramping (from T+10 to T+20)

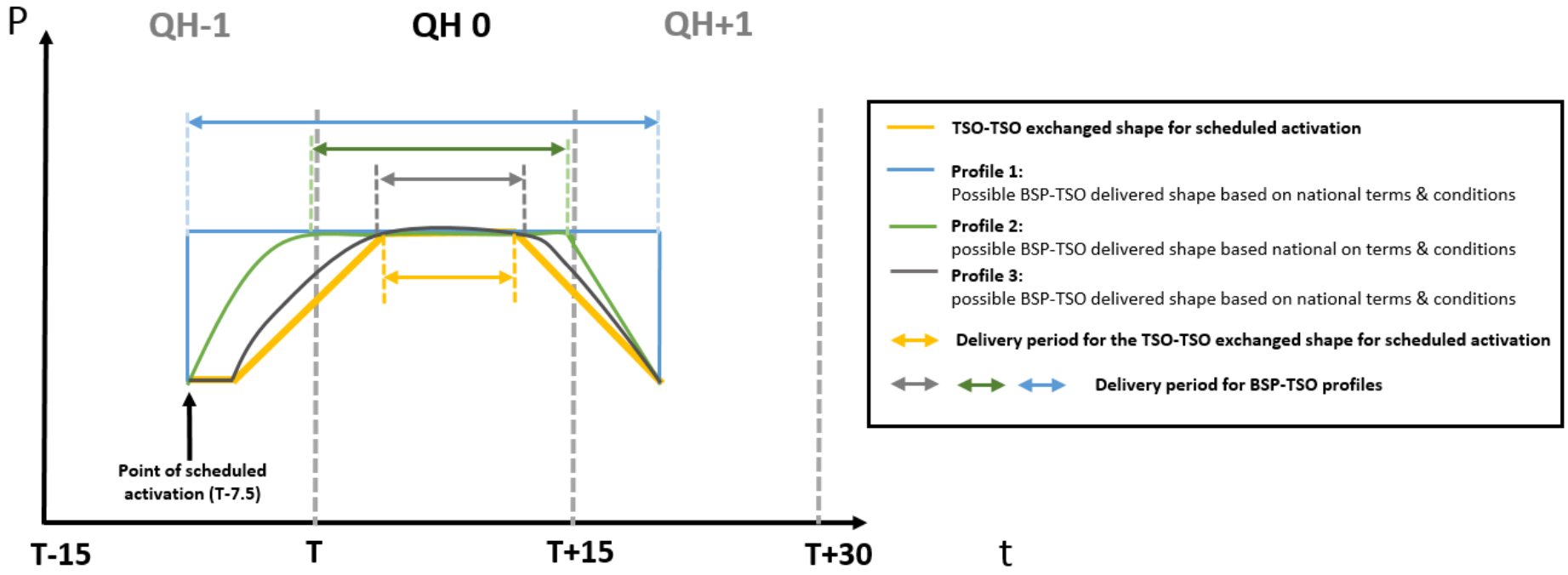
- *Direct Activation* will **run on-demand**, with delivery from the **remainder of one quarter hour and to the end of the subsequent quarter hour**.
- TSO – TSO delivery shape* (*Direct Activation* in QH0):
  - 12.5 minutes Full Activation Time, consisting of
    - 2.5 minutes preparation time
    - 10 minutes start ramping
  - **5 – 20 minutes full delivery (from T+X to T+25)**
  - 10 minutes end ramping (around the end of QH+1, i.e. from T+25 to T+35)



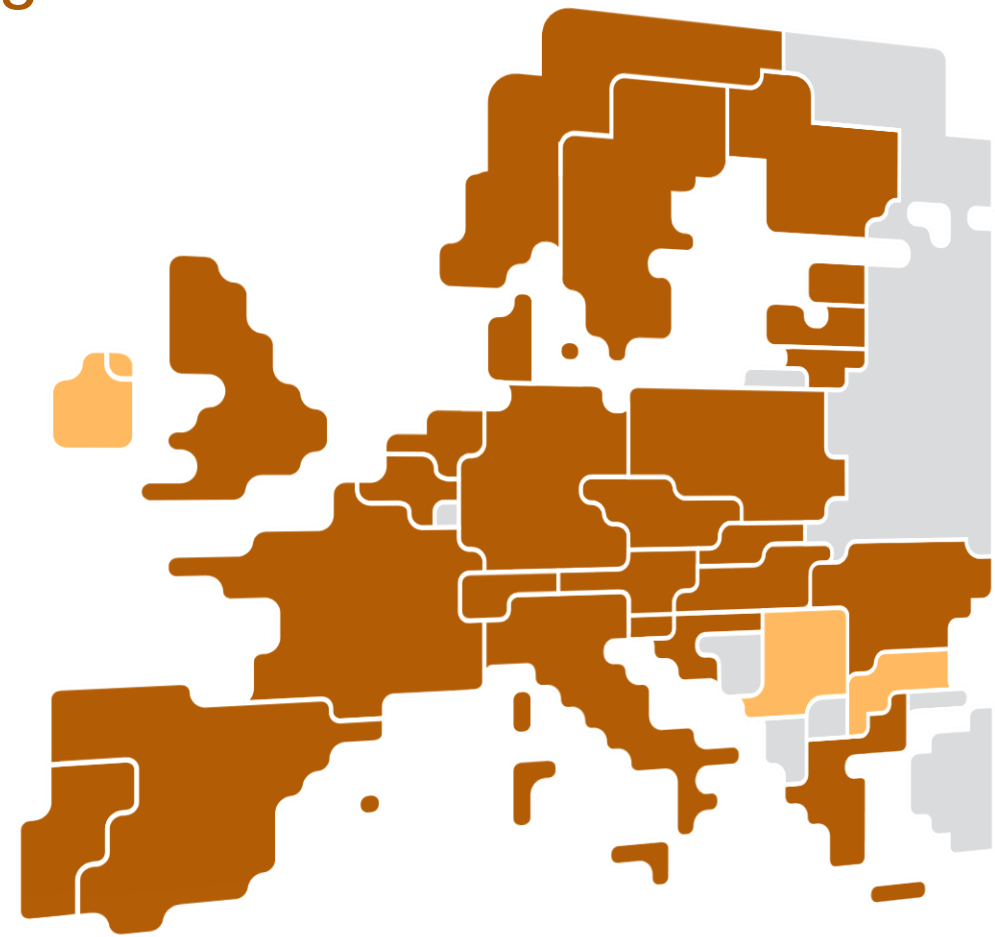
*TSO – BSP delivery shape will be defined in the national terms and conditions

BSP-TSO Delivered Shape

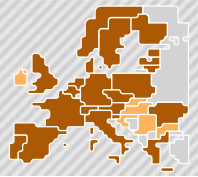
- The *'BSP-TSO delivered shape'* refers to the actual delivery/withdrawal of certain units.
- Given the variety of **intrinsic differences** between local markets, TSOs management of the system, and pre-qualification requirements **defined in the terms and conditions for BSPs**, bid characteristics defined in the terms and conditions for BSPs **cannot easily be harmonized** across Europe **at this moment**.
- Below, different possible BSP-TSO delivered shapes are illustrated. These are **examples only** (for scheduled activation) and will be defined locally within each country. **Similar or same rules** shall be defined for **direct activation.**



MARI bidding design



Bidding Design



Bidding process from BSP to TSO to mFRR-Platform.

- The BSPs enter their bids to the connecting TSO according to the **standard defined locally** (format, tool …). Every TSO has to submit the energy bids received from BSPs to the mFRR-Platform.
- Every energy bid entered to the connecting TSO is available for scheduled activation (SA).
  A BSP can further choose if a bid is additionally available for direct activation (DA).
- When submitting a **bid available for DA** that the activation of a bid in the DA optimization results in **a delivery extending into the next quarter hour.** The BSP must be able to perform this delivery.

Type of bids (within one MTU)**:**

- (Full) Divisible bids
- Indivisible bids

Simple bids –
one bid, one price

- Exclusive bids
- Multipart bids

Complex bids –
combination of simple bids

Linkage of bids (between MTUs)**:**

- Technical linkage
- Conditional linkage

- Bids may be **divisible** or **indivisible**
- The **bid size** may not be smaller than **1 MW** and not greater than **9.999 MW**
- Divisible bids may be activated in incremental **steps of 1 MW** from the minimum offered quantity up to the maximum offered quantity
- Bids price may **be negative, positive or zero**.
- Both the offered and the accepted **price resolution** is **0,01 €/MWh**.

Bidding Design

Simple bids

Simple bids are those bids, which are **not linked together** in any form.

Every simple bid is characterized by a **unique price.** The **offered volume** determines the size of the bid.

All simple bids can be marked available for DA (to be defined locally).

Bid	
Price	**y** €/MWh
Offered Volume	**x** MW
Min offered volume	**z** MW

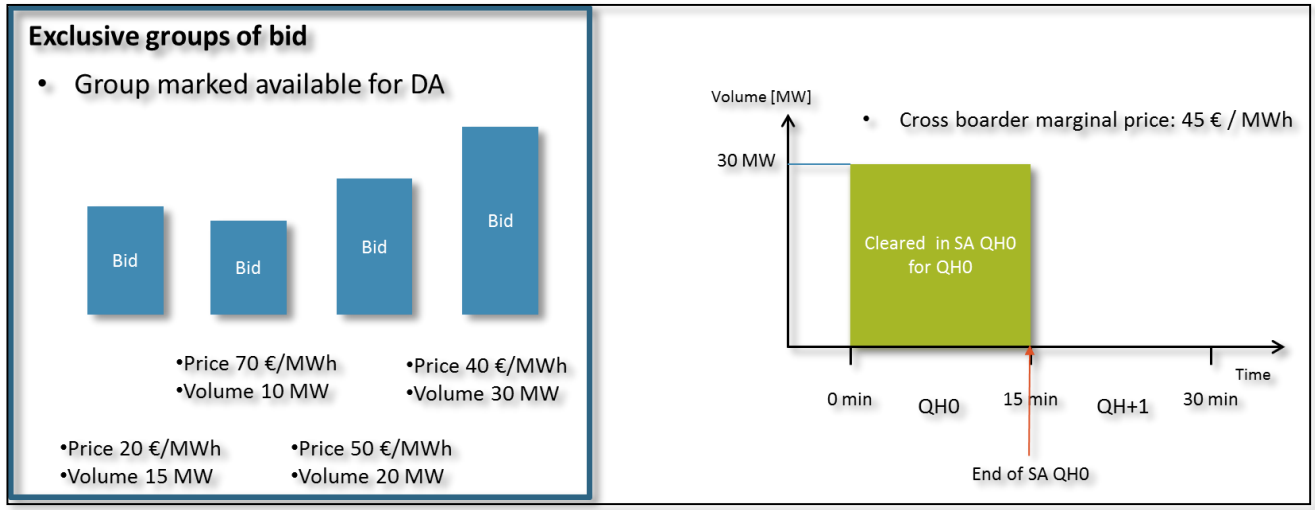
Depending of the size of the minimum offered Volume (parameter z); the following types of bid can be modelled.

	Fully divisible bid	Indivisible bid	Divisible bid
Price	**y** €/MWh	**y** €/MWh	**y** €/MWh
Offered Volume	**x** MW	**x** MW	**x** MW
Min offered volume	**z** MW Where z = 0 MW	**z** MW Where z = x MW	**z** MW Where: 0 MW < z < x MW

The TSOs may facilitate the process, it will be a **national decision** what will be the parameters and how the BSP should provide the information to the TSOs

Exclusive groups of bids

- mutually exclusive according to the principle „**exactly one or none**"
- all bids can be divisible, indivisible, and fully divisible
- may have **different prices, volumes and directions**
- always refer to **the same MTU** (15 min)
- if the group was not activated in SA, it **can be cleared in DA**
- all the bids in an exclusive group should have the same activation type



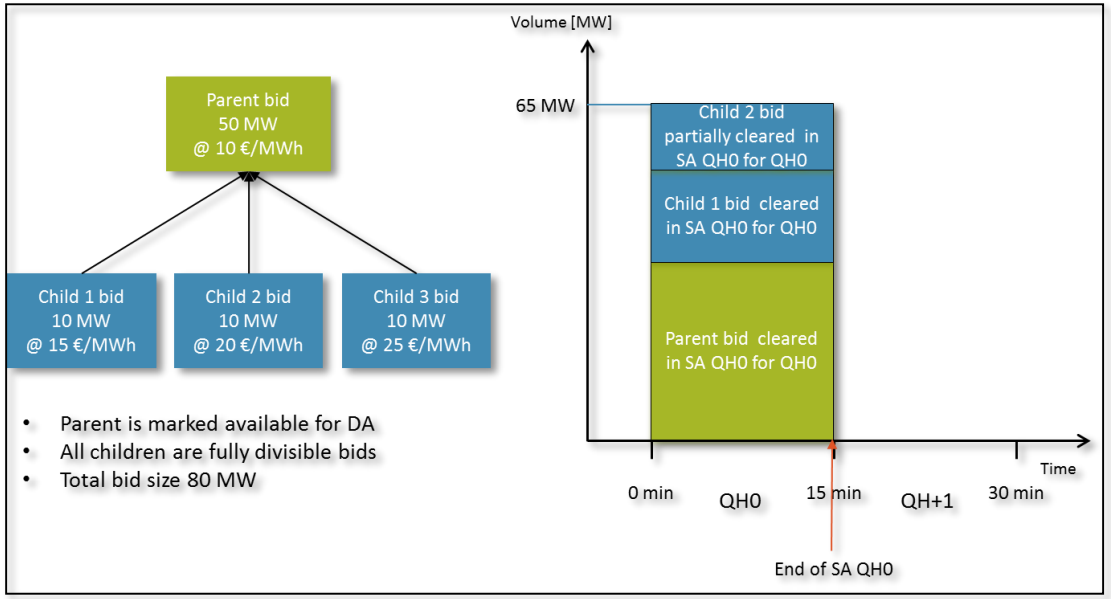
Exclusive bids intend to give to BSPs the **opportunity to model their costs**:

E.g. Turbojet or Diesel engines with start-ups costs (fixed) and fuel costs (variable cost),

FC [€/MWh]>VC [€/MWh]

Multipart bid (Parent – child bid)

- Multipart bid/Parent-Child bid intends to give to BSPs the **opportunity to model their costs**:
  - E.g. Generation or battery above nominal power (additional maintenance costs, diminished lifespan) **FC [€/MWh]<VC [€/MWh]**



- Bids can be (fully) divisible or indivisible
- Must cover the **same MTU period** and have **the same direction**
- The **activation type should be the same** for all bids of the multi-part bid.
- **All bids** in the multi-part bid **should have different prices**.

  The parent bid will be the cheapest one for the positive direction and the most expensive for the negative direction.

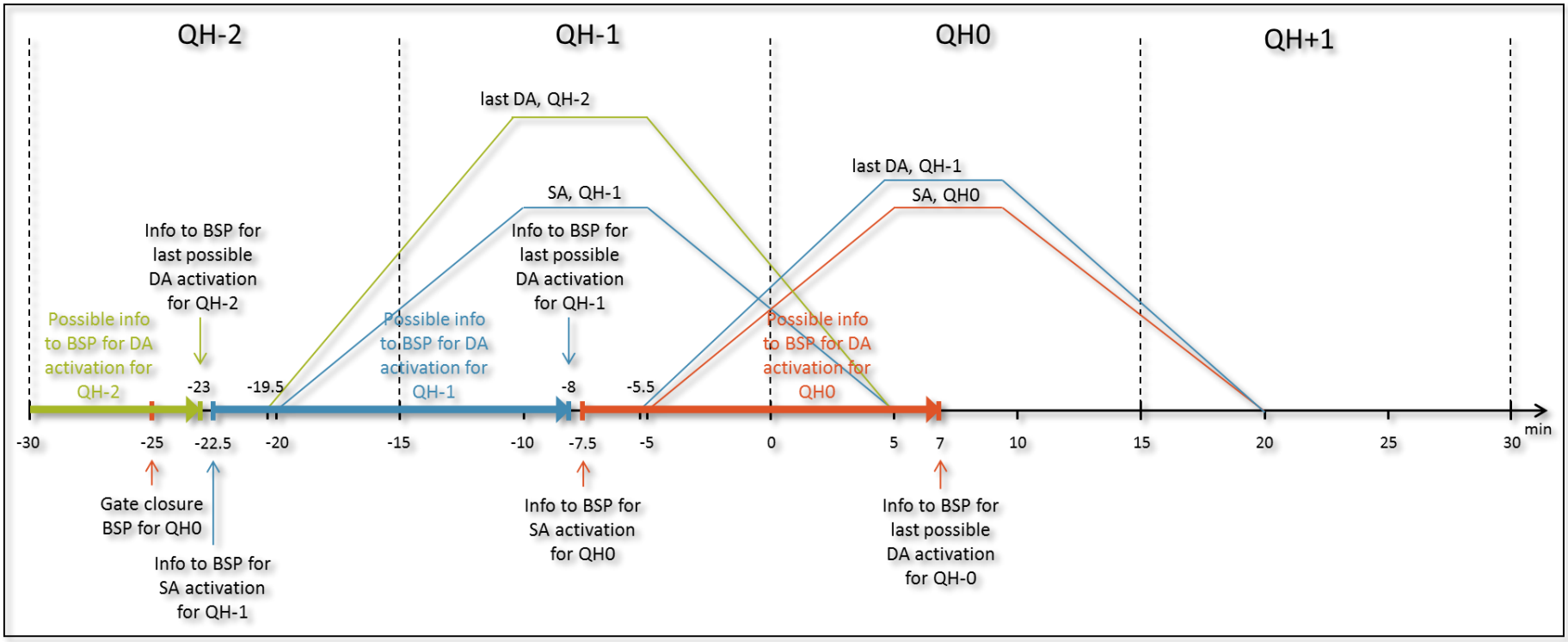
- If a downward multipart bid is accepted – **all associated bids with higher price must also be accepted**
- If an upward multipart bid is accepted – **all associated bids with lower price must also be accepted**
- If **any component / any bid** in the multi-part bid **is accepted in SA**, **none** of the other components **would be available in DA**.

Bidding Design

Linkage of bids

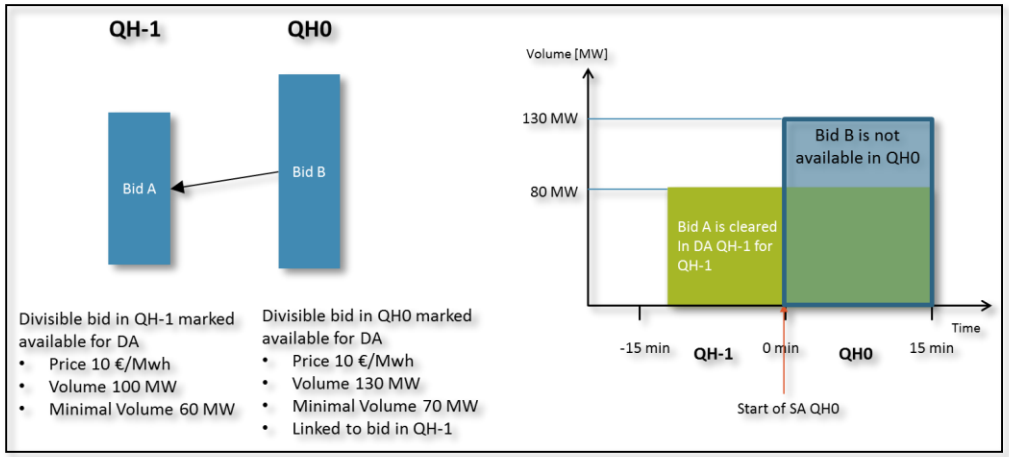
- BSP can either link bids together with a **technical link** or with a **conditional link**
- TSOs are still investigating the interaction between technical and conditional linking, **the content presented is subject to change and** may be adapted by the TSO.
- Technical and conditional linking **are not mutually exclusive**

The linkage of bids between consecutive quarter hours is needed, because at the gate closure time QH0 (current QH) for BSPs, the BSPs do not have the knowledge, if their bid was activated in QH-1 (previous QH) either in SA or DA or if their bid was activated in QH-2 in DA.



Linkage of bids

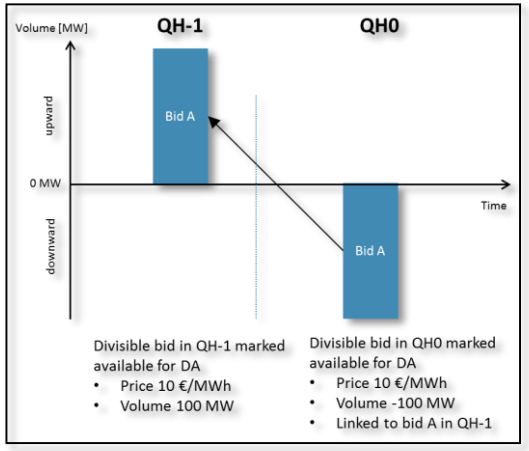
Technical linkage is the linkage of two bids (simple or complex) in two or three subsequent quarter hours. Bids must be identifiable with a unique ID and it remains the responsibility of BSPs to correctly identify their bids, in order to avoid unfeasible activations (e.g. double activation of the same resources)



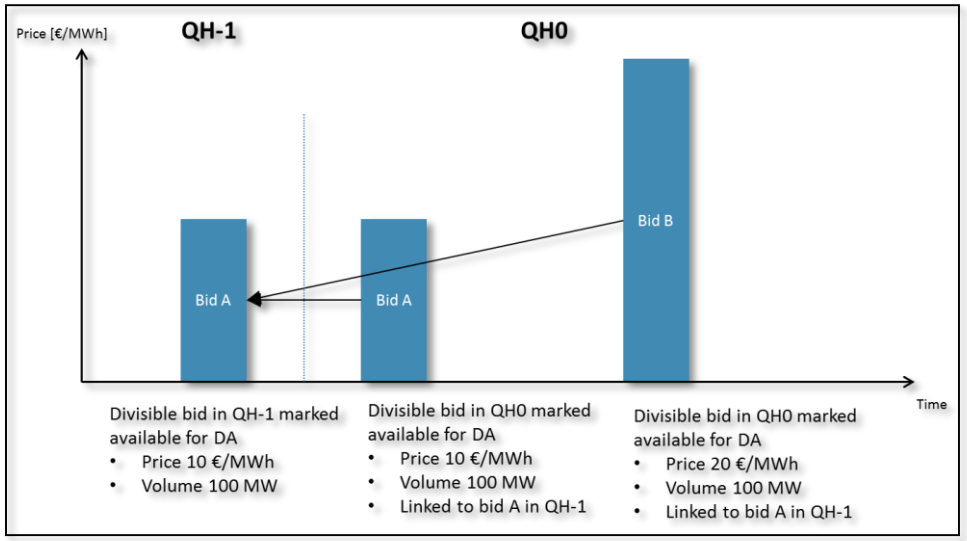
It defines if a bid in QH0 is available for clearing if the bid in the QH-1 **was not activated in DA**. Technical linkage **avoids the activation of the same** balancing **resource** twice.

BSPs will have to indicate upfront whether such bids are available or not in QH0 or QH1. The conditionality always refer to the outcome of the bid in QH-1:

1. A bid that underwent **scheduled activation in QH-1** may or may not be available in QH0 for direct activation, **depending on ramp-up/down** capabilities as indicated by the submitting BSP. **The bid in QH0 is assumed not available**.
2. A bid that underwent **direct activation in QH-1** may or may not be available for direct activation in QH1, **depending on ramp-up/down capabilities** as indicated by the submitting BSP. **The bid in QH1 is assumed not available**.



Conditional linkage is similar to technical linkage and aims to change the availability of one or multiple bids under certain conditions. It is only applicable to simple bids for the Go-Live of the mFRR-Platform.

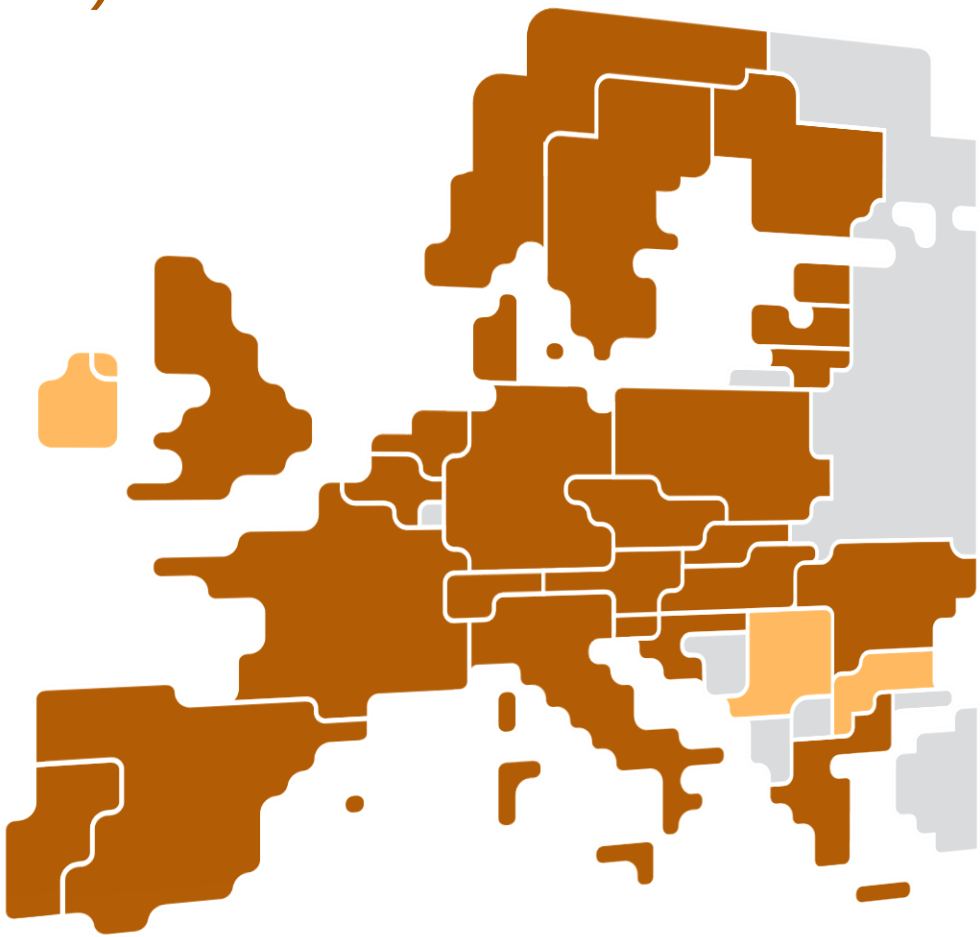


- Conditional linkage is needed because the BSP do not know at gate closing QH0, if their bid in QH-2 was activated in DA or if their bid in QH-1 was activated in SA or DA.
- **Due to constraint** a bid in QH0 might or might not be available for clearing if bid in QH-1 was activated in SA or bid in QH-2 was activated in DA.
- The conditionality always refer to the outcome of the associated bid in QH0. In QH1 there may **be zero, one or two bids.** In QH2 there may **be zero, one or two bids**.

One bid or two bids in QH0 can be linked to one bid in QH-1 (previous QH) or a bid of QH-2 in DA. Bids in QH0 are available for clearing depending if bid in QH-1 or in QH-2 was activated or not. Following rules are foreseen:

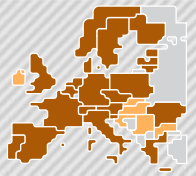
- If bid A in QH-1 is activated in SA, bid B is not available in QH0 and bid A is available in QH0
- If bid A in QH-1 is not activated, bid B is available in QH0 and bid A is not available in QH0
- If bid A in QH-2 is activated in DA, bid B is not available in QH0 and bid A is available in QH0
- If bid A in QH-2 is not activated in DA, bid B is available in QH0 and bid A is not available in QH0

MARI algorithm (AOF)



Algorithm AOF

Description of the design and operation of the AOF



- ✓ AOF is formulated as a **Mixed Integer Linear Programming Problem** (MILP).

- ✓ AOF shall perform optimization for a **given MTU period only**. There is no requirement to optimize activations for more than one MTU period at the same time.

- ✓ The maximum allowed execution time for the AOF is defined for every execution, with a precision of seconds. There shall be **separate limits on the execution time for scheduled and direct activations**, respectively.

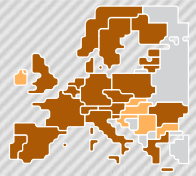
- ✓ Direct and scheduled activations use the same AOF with different input data. Updates will be performed taken into account previous results.
  - ✓ For the SA, **all bids are considered.**
  - ✓ For the DA, **only upward or downward CMOL is used.**

- ✓ The AOF shall be able to perform the following two modes of optimization in parallel:
  - **coupled optimization** (i.e. resulting cross-border energy flows permitted up to the CBCLs and applicable technical profiles and limits on net positions)
  - **decoupled optimization** (i.e. all areas are optimized in isolation with CBCL set to zero on borders between them)
  - As a general principle, the results of the coupled optimization are valid for selection of bids. But the results of the decoupled optimization can be used as fallback.

Output:
- Activated bids per scheduling area

Algorithm AOF

Description of the design and operation of the AOF



Objective of the AOF is to maximize social welfare. As a secondary objective, the minimization of cross-border exchanges.

Inputs of AOF

- CMOL, considering availabilities:
  - for SA, **both upward and downward**;
  - for DA, **one CMOL**
- Inelastic and elastic demands from TSOs
- Available CBCL
- Technical profile and net position limits
- Other (guaranteed volume and desired flow ranges)

Outputs of AOF

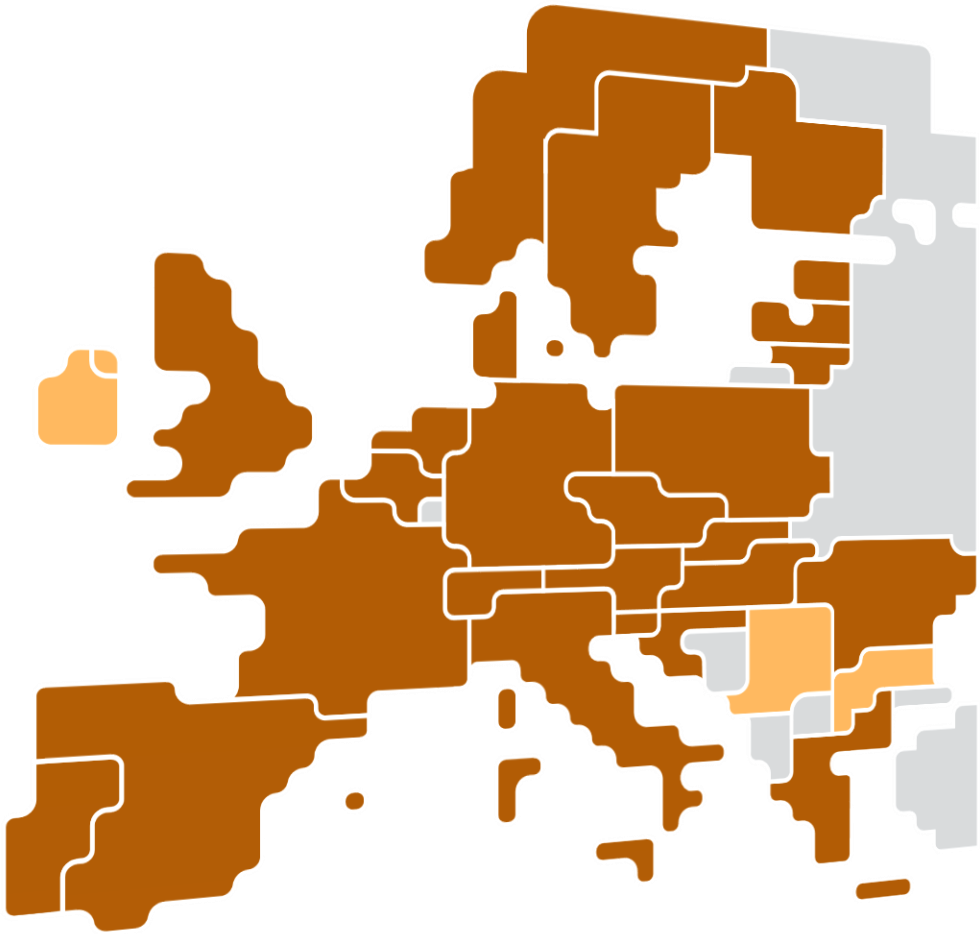
- **Cross-border marginal prices (CBMPs)**
- **Satisfied demands**
- Net position of each scheduling area
- Cross-border flows in the interconnectors (AC and HVDC).
- Remaining cross-border capacity
- **Selected bids (and volume)**
- Execution statistics

Market rules

- Maximize satisfaction of inelastic demand
- **Forbid UAB** (unforeseeable accepted bids)
- **Penalization of URdB** (unforeseeable rejected bids)
- Minimize distance to target price*
- Maximize traded volume (in case of price indeterminacy)*
- Maximize satisfaction of desired flow ranges**
- **Price convergence in uncongested areas****
- **Forbid adverse flows****

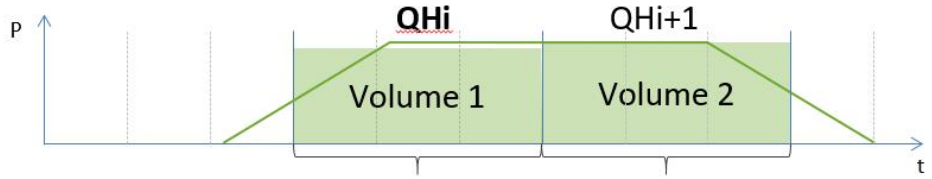
* currently pending further investigation
** behavior of the AOF in case of DFRs is under analysis

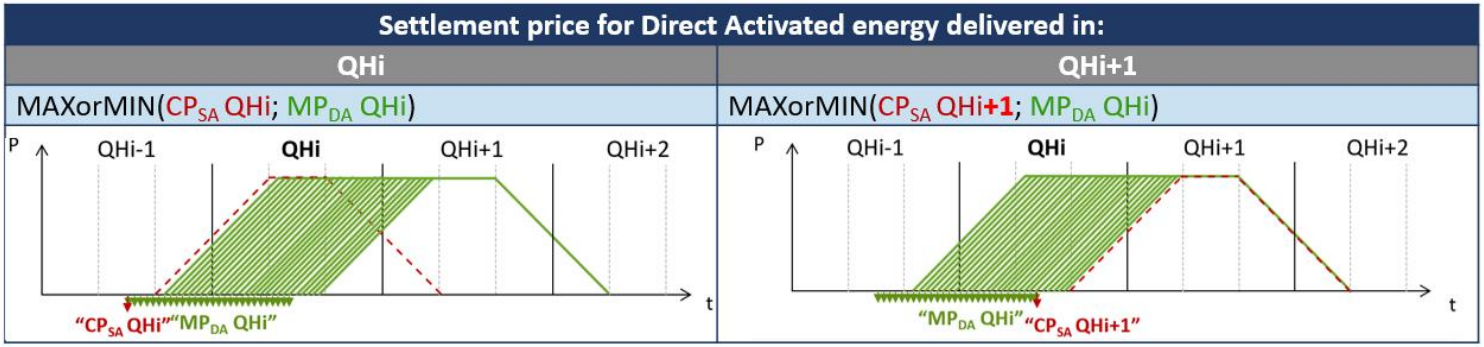
mFRR Pricing



Pricing

- **Marginal pricing** is the general principle for determining the settlement prices for activated volumes.
- For scheduled activation, **the CBMP is equal or higher* than the most expensive** activated bids
- For direct activations, there are **two CBMPs for both quarter hours** affected by the direct activation

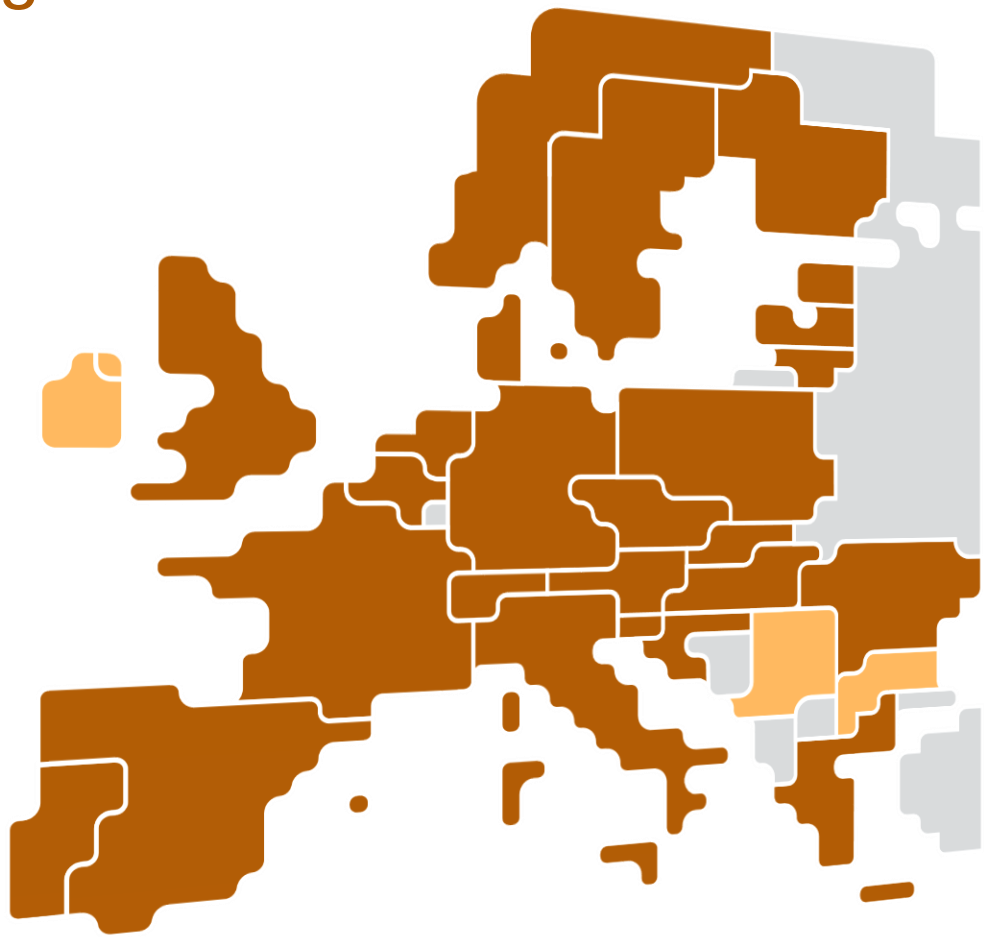




- For volume in QHi: maximum from all direct activations in QHi and the SA QHi
- For volume in Qhi+1: maximum from all direct activations in QHi and the SA Qhi+1

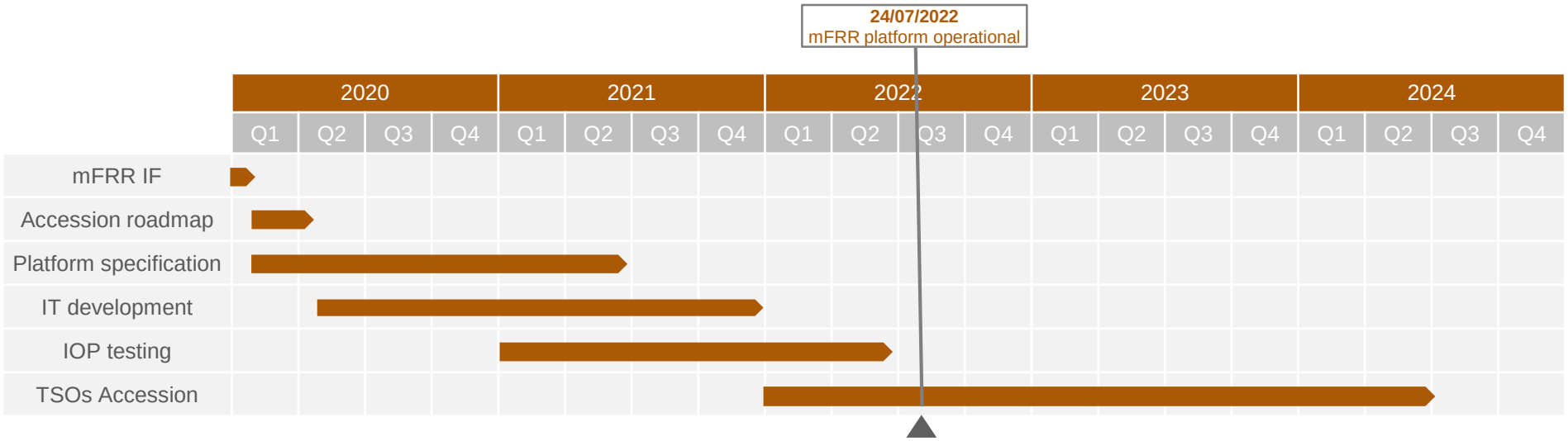
* In case of price indeterminacy

MARI Project timing



Project Timeline

TSOs establish project planning until 2024 to include all MARI partners

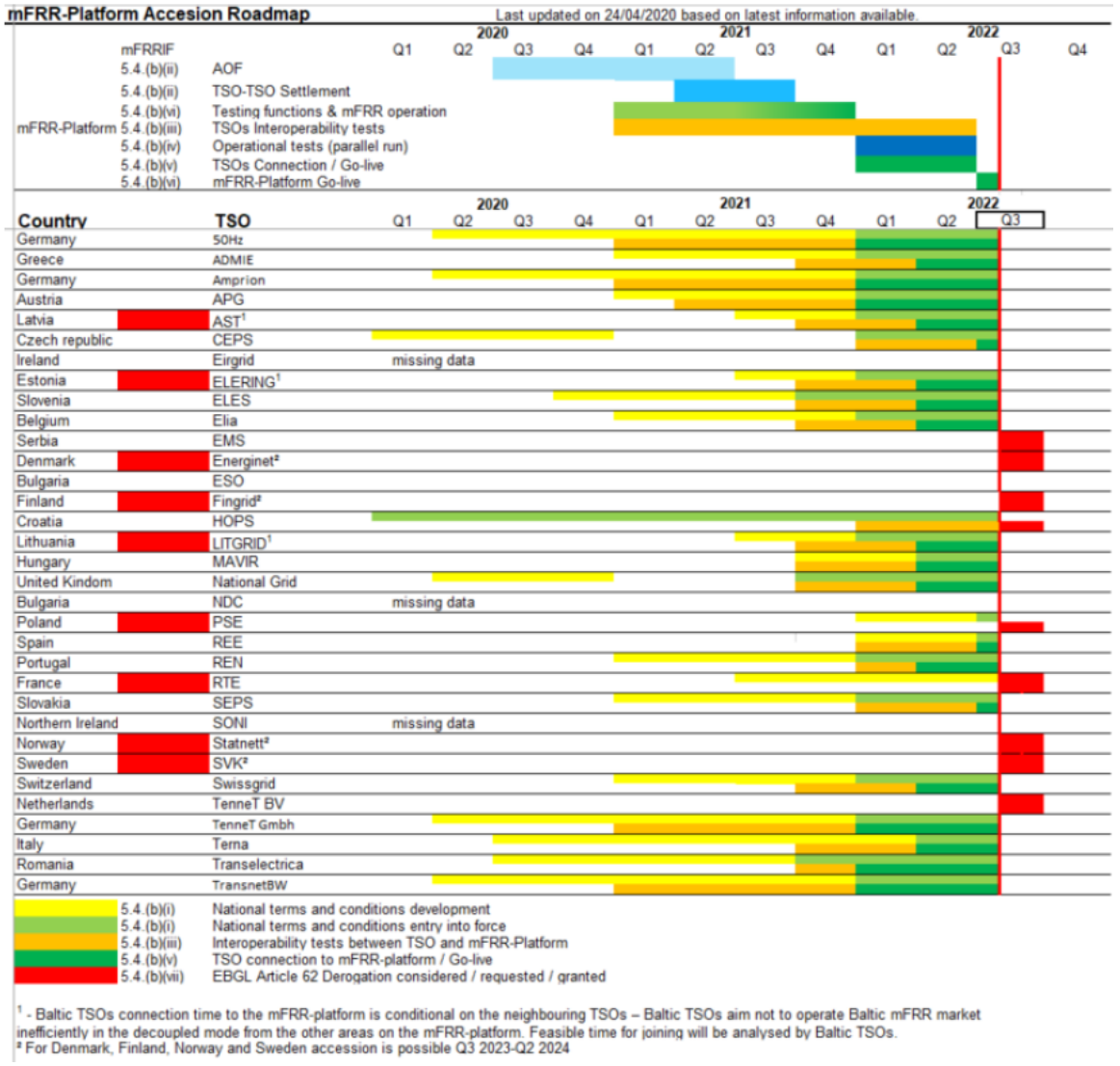


- The mFRR IF (Implementation Framework) is approved by ACER on 24th of January 2020
- TSO have published their planning for accession to the platform on 24th of April 2020

- The detailed platform specification will be done until the first half of 2021
- IT development will end in Q3 2021
- TSO will join the platform sequentially

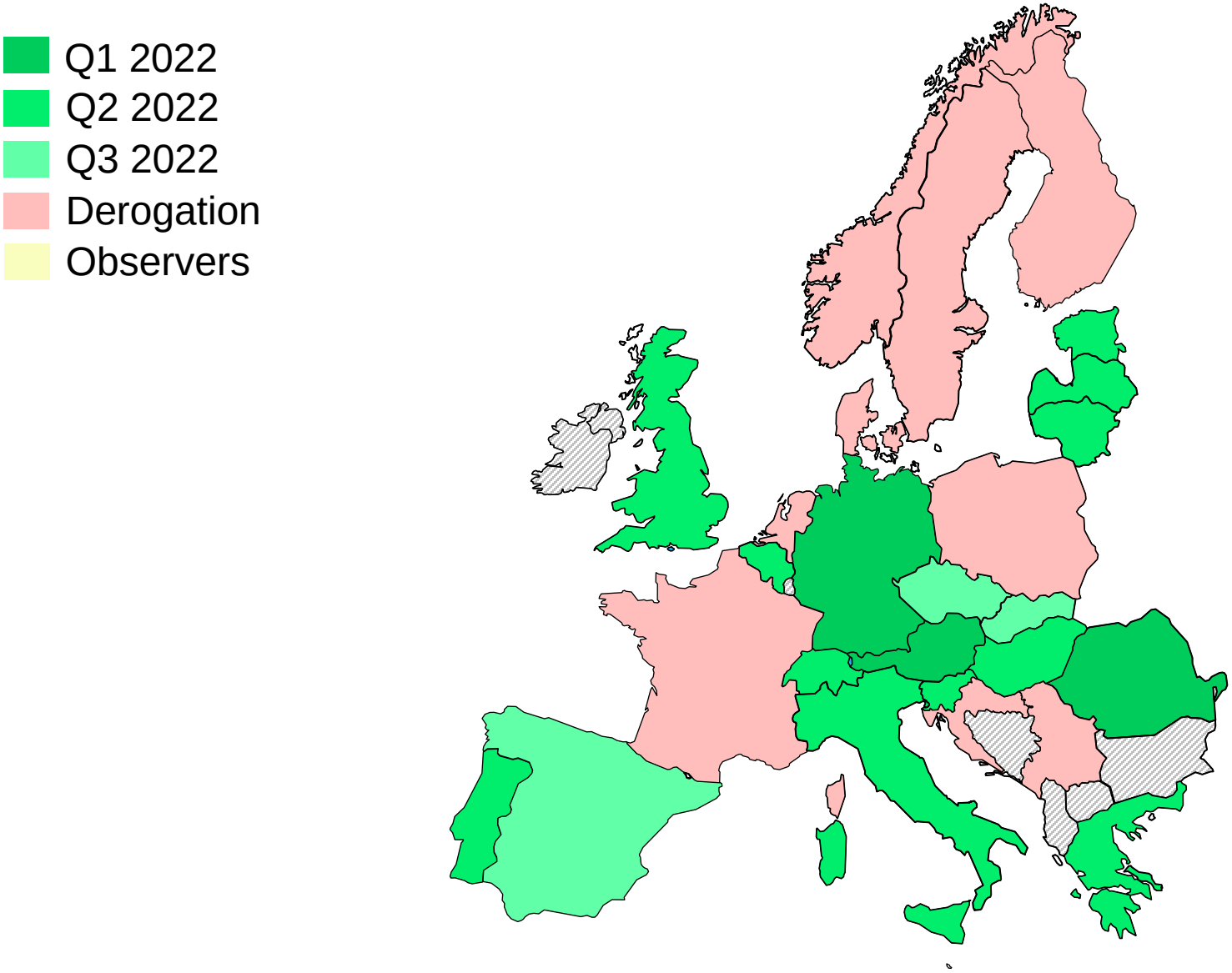
Accession Timeline

- ENTSO-e published the mFRR-Platform Accession roadmap on 24th April 2020
- The accession of member TSOs to the platform (MARI) is planned in accordance with this timeline.
- The accession roadmap for **informative purposes only** and does not, in any case, represent a firm, binding or definitive position of MARI on the content.
- This timeline will be **updated at least twice a year** to give stakeholders updated information.
- Several TSOs are considering applying for **a derogation to the EBGL requirement to connect to the platform by Q3 2022**; such derogation is subject to the approval of the relevant NRA.



MARI Accession Roadmap

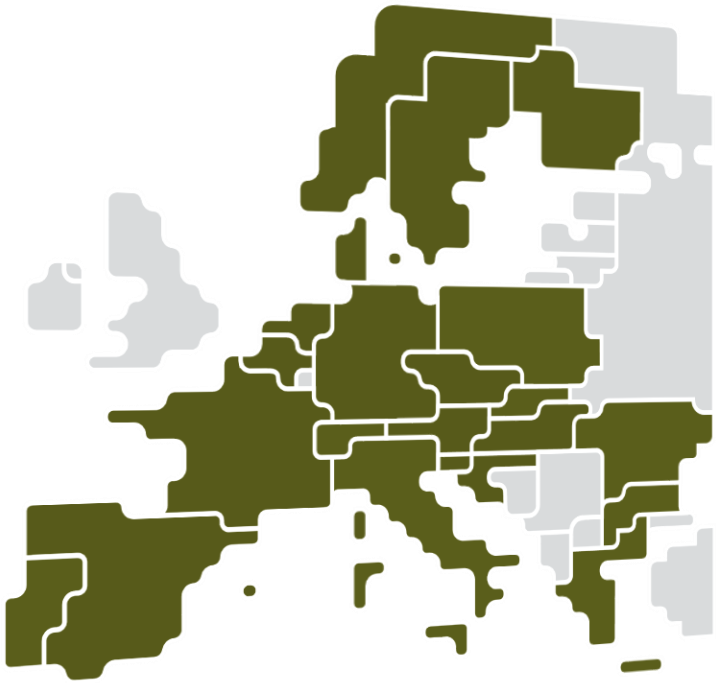
Accession overview

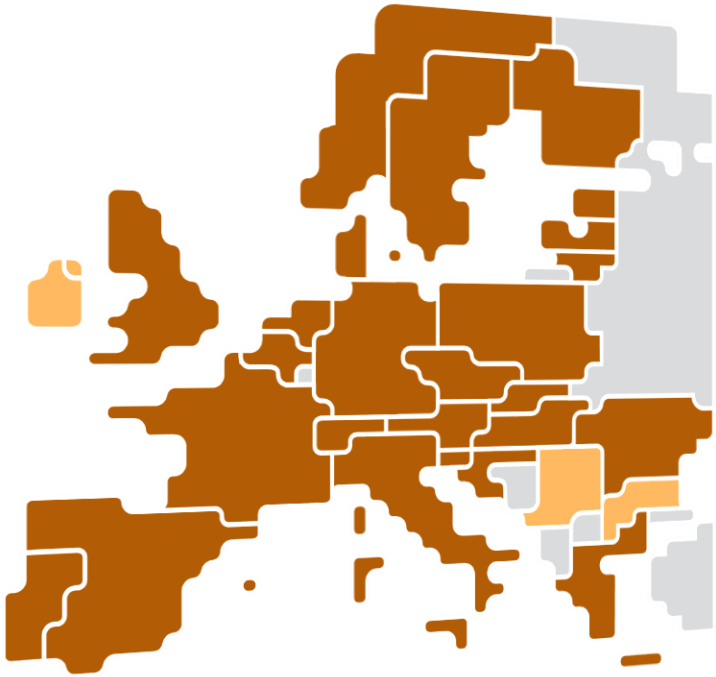


Stakeholder workshop

MARI & PICASSO

13 July 2020 (webinar session)





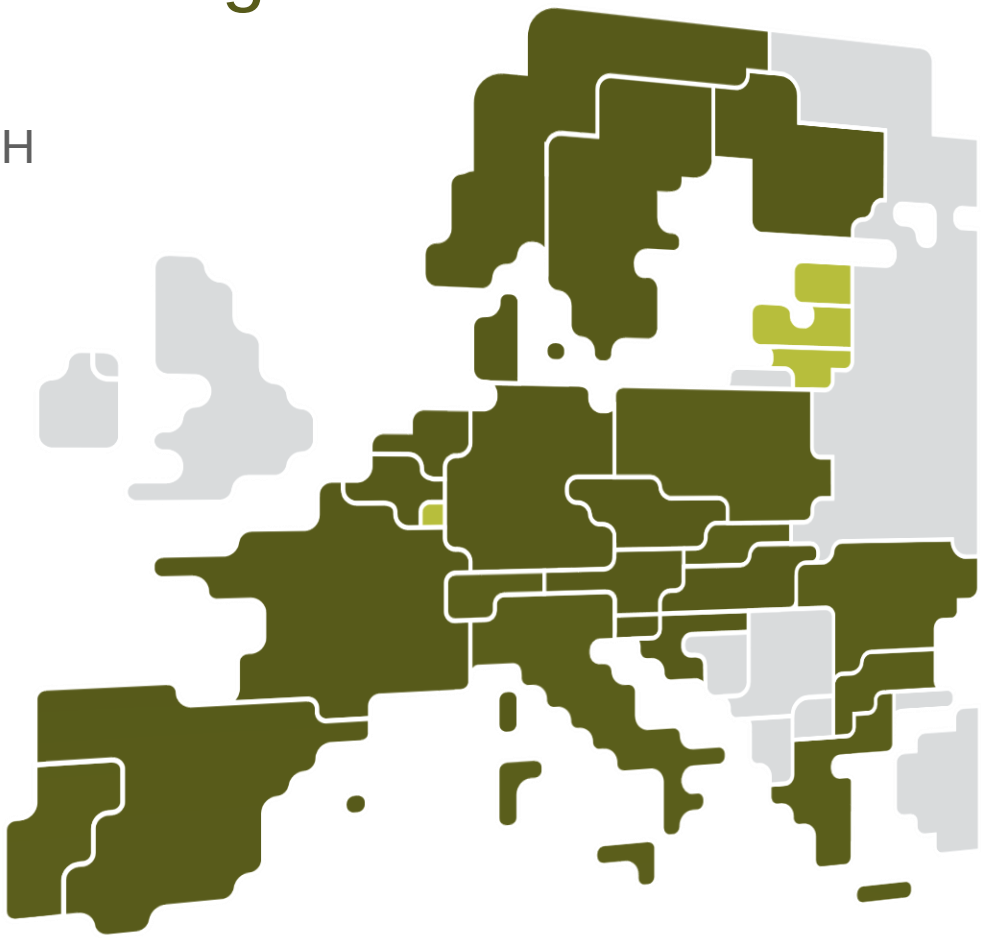
1. Welcome and introduction

Agenda

	SUBJECT	WHO	TIMING
1	**Welcome & Introduction**	ALL	
2	**PICASSO platform design**	SIMON	
3	**PICASSO optimization function**	DOMINIK	
4	**PICASSO accession roadmap**	JIRI	
5	**PICASSO pricing and settlement**	MARTÍN	
6	**Gate closure planning aFRR and mFRR**		
7	**Publishing and Reporting Obligations of MARI and PICASSO**	IGOR	
8	**Closure**	ALL	

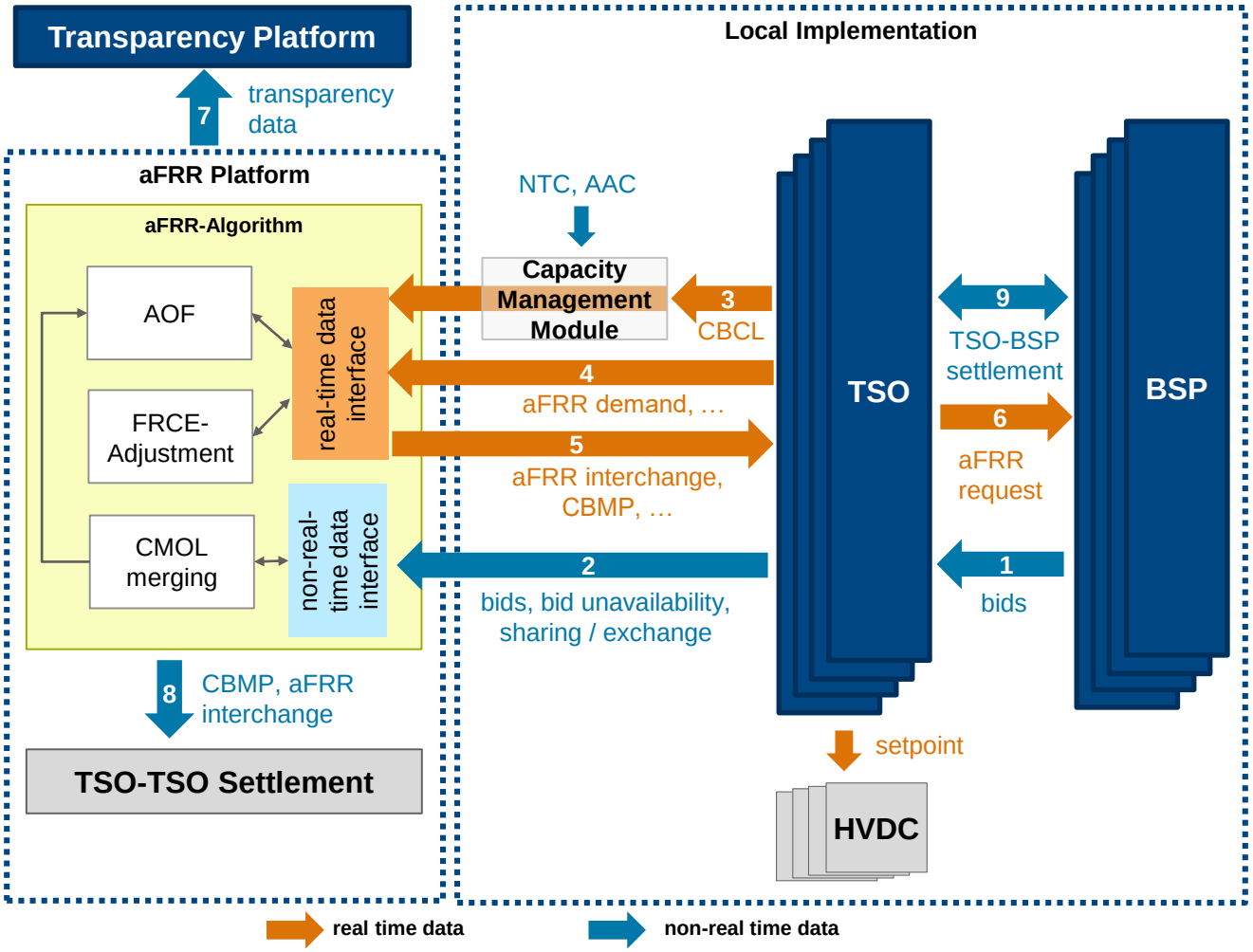
PICASSO Platform design

Simon Remppis
TransnetBW GmbH



PICASSO Platform design

PICASSO High Level Design



AOF	Activation Optimisation Function	NTC	Net Transfer Capacity
FRCE	Frequency Restoration Control Error	AAC	Already Allocated Capacities
CMOL	Common Merit Order List	CBCL	Cross-Border Capacity Limits
CBMP	Cross-Border Marginal Price	HVDC	High Voltage Direct Current

1. TSO receives bids from BSPs in their LFC area
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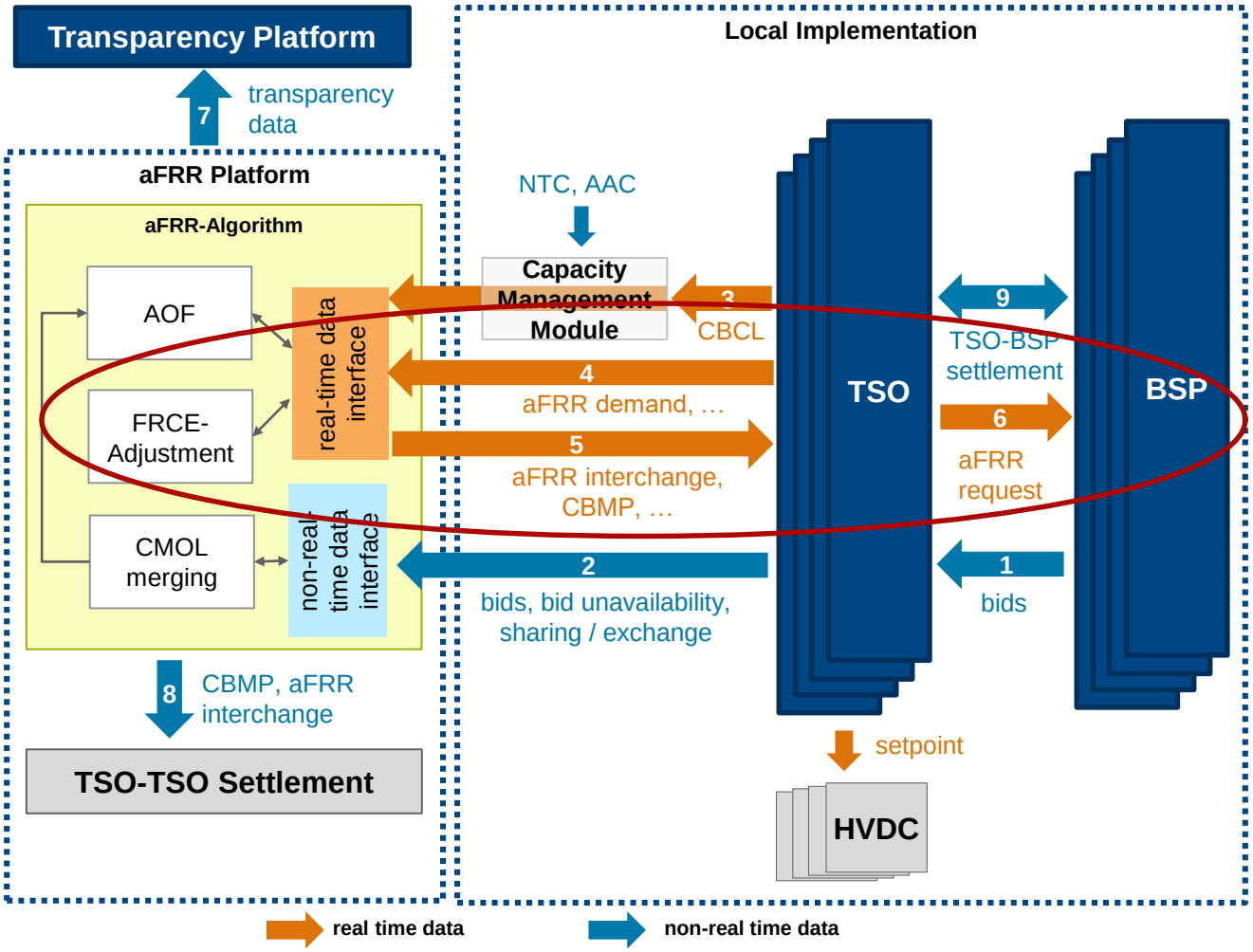
5. Communication of clearing results to TSO
6. Communication of aFRR request from each LFC to BSP
7. Data Publication
8. TSO-TSO settlement process and invoicing
9. TSO-BSP settlement process and invoicing

PICASSO Platform design

Control Concept



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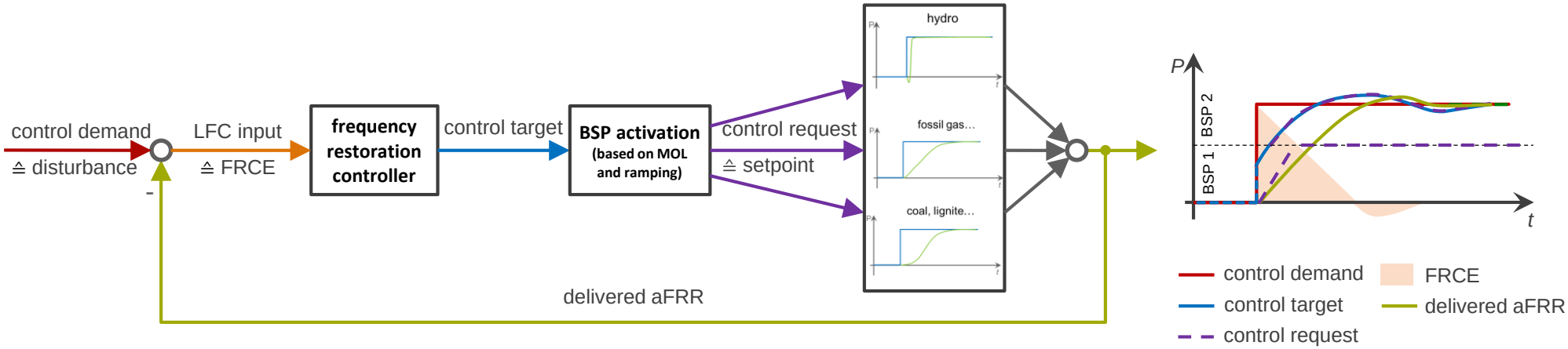
PICASSO Platform design

Basics of the automatic frequency restoration process



Basic Principle

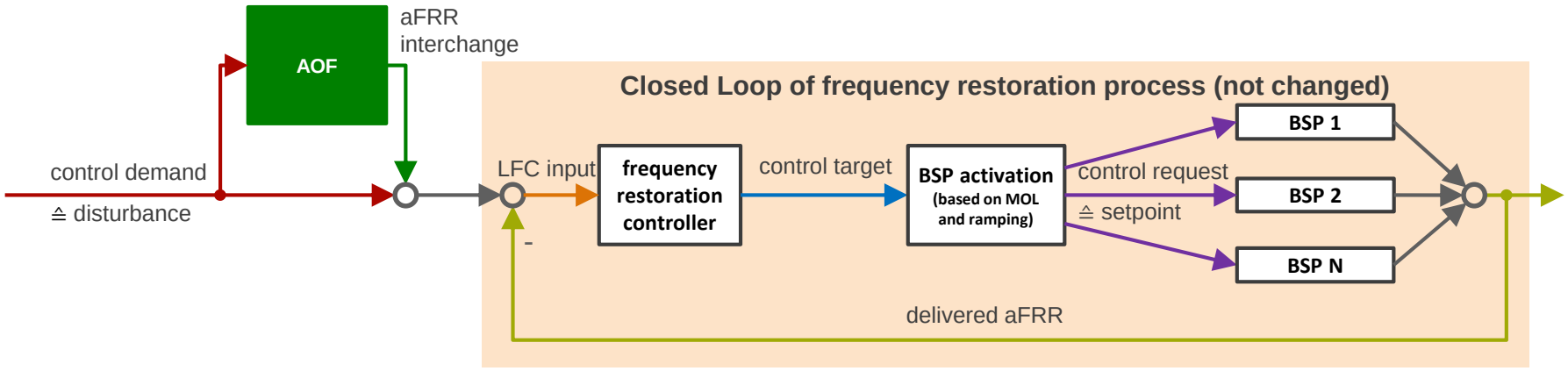
- Objective: regulate FRCE (difference between disturbance and activated aFRR) to zero and by this restore frequency deviations
- The disturbance cannot be known in advance, and the aFRR is activated with a certain delay according to the FAT, thus the FRCE cannot be completely avoided
- Based on the FRCE, the controller (proportional-integral controller) calculates a control target value, which is distributed to different BSPs according to the MOL. The BSPs serve as actuator of the control loop.
- Each TSO is responsible to perform this process within its LFC area and by this fulfill the FRCE quality target. This responsibility will not change with the implementation of the European Platform.

BSP impact

- The performance of the process depends on the dynamic behavior of the BSPs
- To ensure a stable process and a good FRCE quality, the controller (and thus the volatility of the control target) has to be adapted to the dynamic behaviour

PICASSO Platform design

The Control Demand Concept



Basic Principle

- Each TSO calculates in each control cycle the demand, which resembles the imbalance before any aFRR activation and provides it to the AOF
- The AOF determines the aFRR interchange based on the CMOL, without considering any ramping constraints

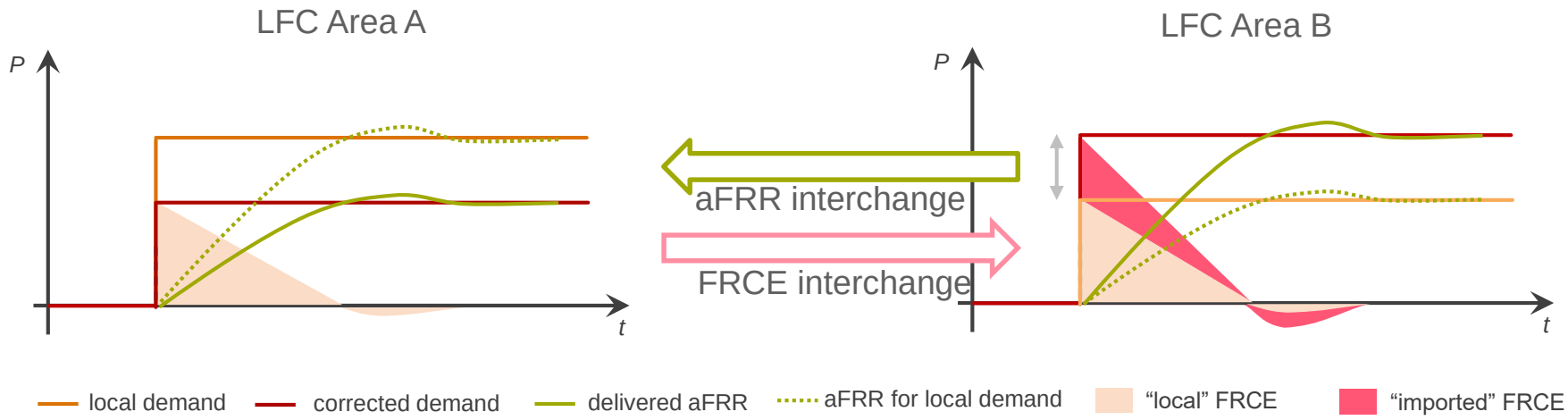
Impact on control loop

- The aFRR interchange values impact only the input of local control loops, thus they act like interchange schedules calculated in real-time
- aFRR exchange **does not interfere with closed control loops** of individual LFC areas, hence the **controllers do not have to be modified/harmonized** and can stay tuned to local BSP dynamics

→ Flexibility of fast BSPs is still utilized, **relieving the need for a short FAT** to maintain frequency quality

Impact on further processes

- Due to the controller dynamics, the control target and **control request will deviate from the aFRR interchange** calculated by the AOF. These deviations will be monitored and published
  - Deviations between local setpoints and price-setting bids →reflected in pricing & settlement methodology
  - Impact on FRCE → mitigated by FRCE adjustment process



Issue

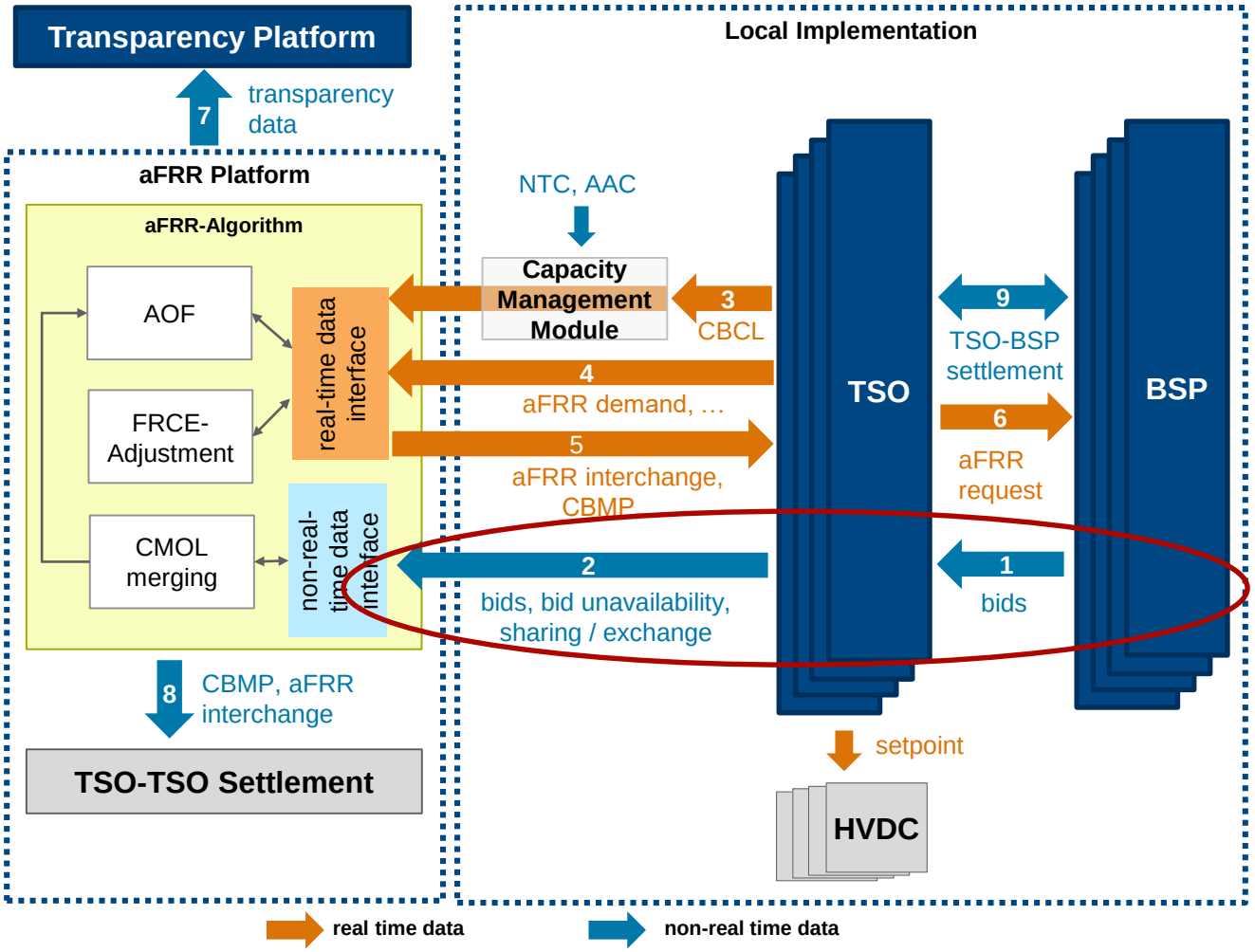
- According to the control demand concept, the aFRR interchange is added as correction to the local LFC input in an unramped manner
- If the local aFRR activation does not perfectly follow the intended aFRR interchange, **the FRCE of the area will be "polluted"** by imported FRCE caused by imbalances in other LFC areas
  - → Possible impact on aFRR dimensioning in case of systematic aFRR export
  - → Possible interference with local balancing strategies depending on FRCE

FRCE adjustment

- FRCE Adjustment process **estimates the origin** of the imbalances in realtime and **adjusts the FRCE** accordingly for monitoring and dimensioning purposes, without impacting the activation
- The adjusted FRCE is allocated based on
  - The aFRR interchange
  - The measured or estimated aFRR activation
  - The minimum ramping requirement for cross-border aFRR interchange

PICASSO Platform design

Standard products



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Full Activation Time (FAT)

- No requirement to harmonize FAT before connecting to the Platform. However, the cross-border aFRR interchange profile has a FAT of 7.5 min, which incentivizes TSOs to aim for a faster activation. FAT harmonization roadmaps will be published by TSOs
- By December 2024, the FAT is **harmonized to 5 minutes**

Minimum bid size and granularity

- The minimum bid size and the bid granularity are **harmonized to 1MW**

Validity Period

- The validity period for aFRR bids is **harmonized to 15 minutes**

Bid Divisibility

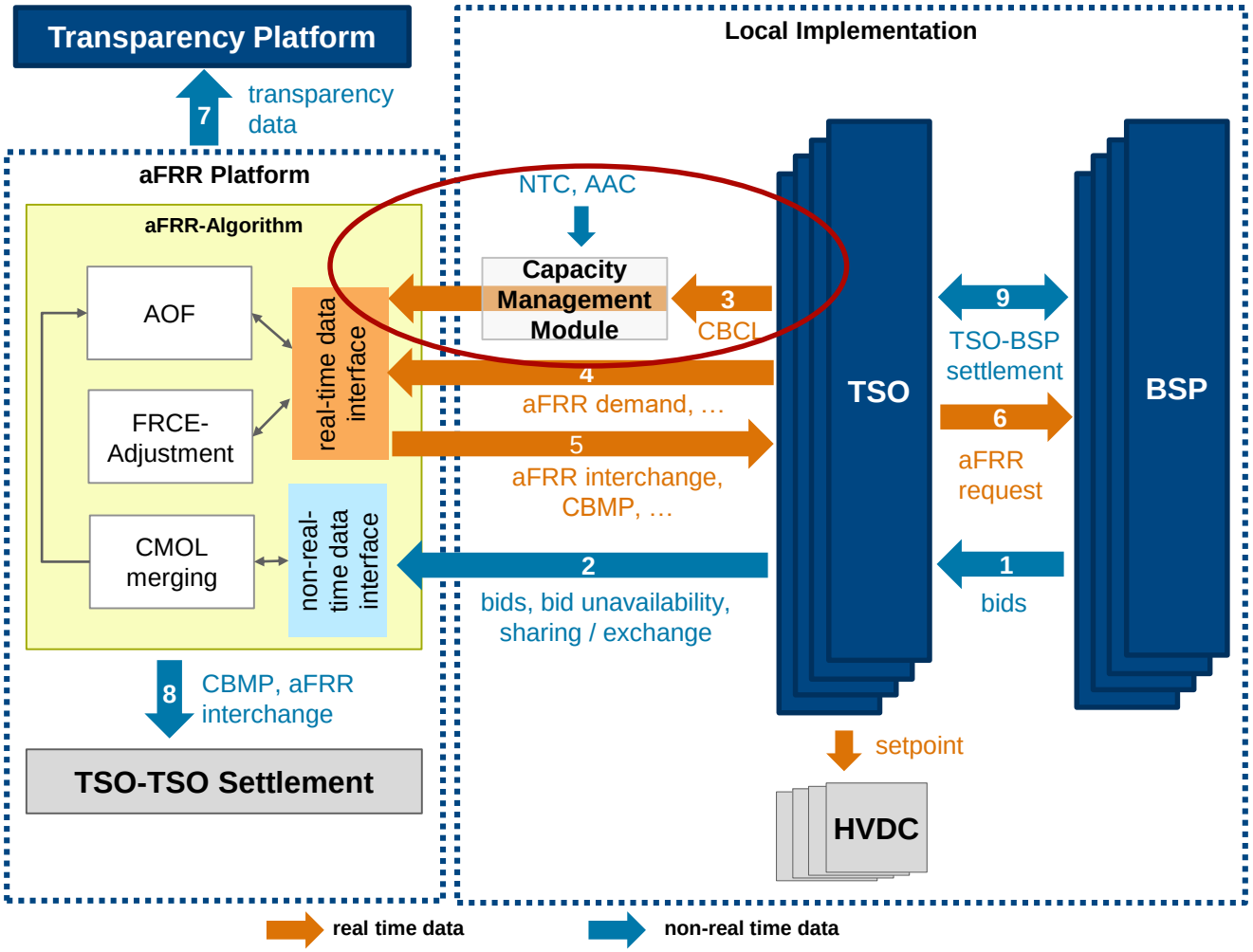
- all aFRR standard bids are **divisible**

Complex Bids

- Complex Bids/Linked bids are not supported by the aFRR platform

PICASSO Platform design

Capacity Management



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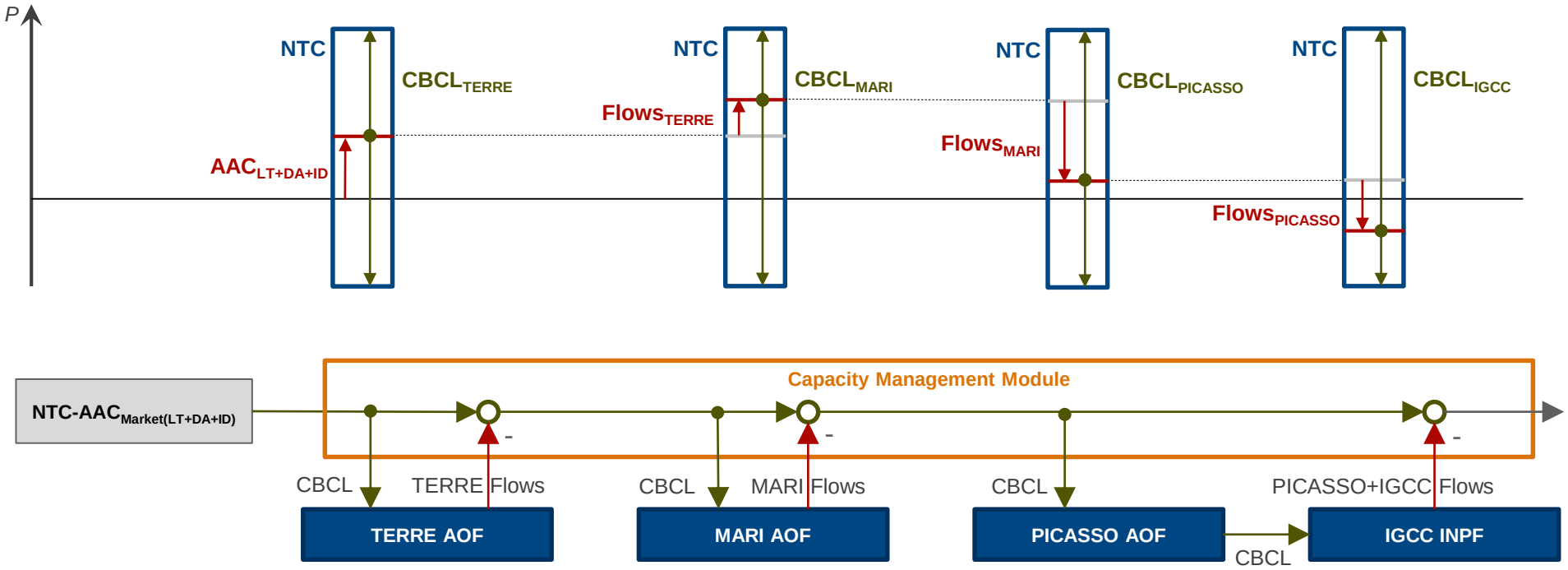
PICASSO Platform design

Capacity Management

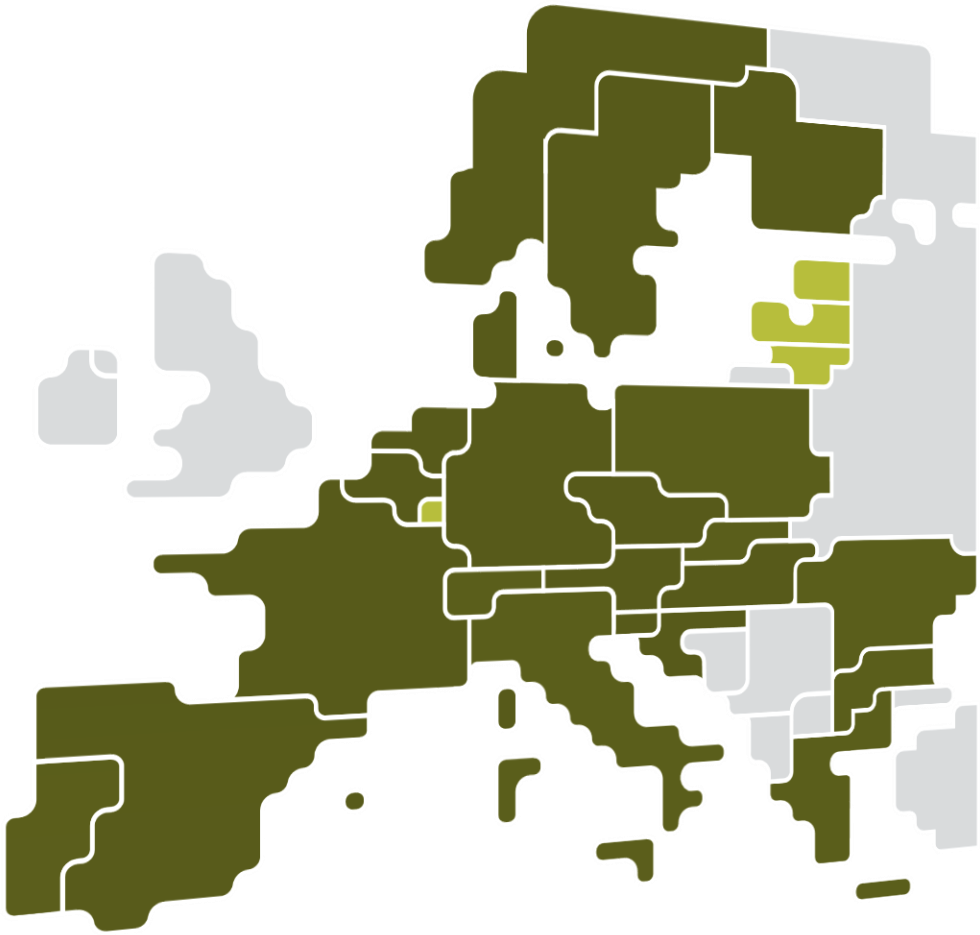


Capacity Management Principles

- Leftover capacity after previous market timeframes (including cross-zonal intraday markets) is made available to the balancing platforms
- Cross-Border Capacity Limits (CBCL) are subsequently adapted by Capacity Management Function to reflect interchange of RR, mFRR and aFRR
- Capacity Management Function will be implemented centrally for all Platforms
- Additional limitations possible to ensure operational security according to SOGL, these additional limitations will be published
- All principles also apply to HVDC interconnectors (additional limitations possible in case of technical inability)

PICASSO Optimization function

Dominik Schlipf
Transnet BW



General Principle of the aFRR Optimisation in the LFC-Controller

EBGL article 31/6 & 31/7

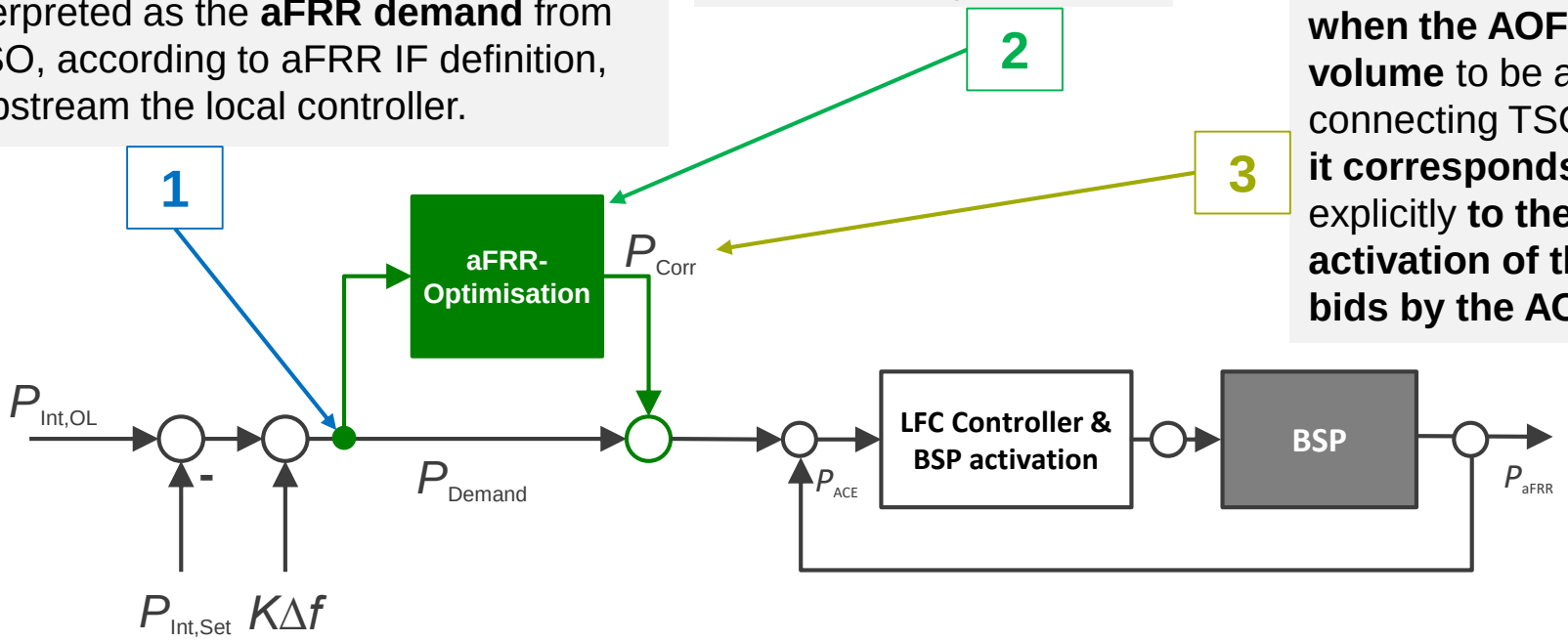
6. Each TSO shall submit its activation requests for balancing energy bids to the activation optimisation function.

7. The activation optimisation function shall select balancing energy bids and request the activation of selected balancing energy bids from the connecting TSOs where the balancing service provider, associated with the selected balancing energy bid, is connected.

The **activation request from the TSO** is to be interpreted as the **aFRR demand** from the TSO, according to aFRR IF definition, and upstream the local controller.

The **AOF** performs an optimisation and **selects the bids** for activation by the connecting TSO

The local MOL and the common MOL are continuously synchronized between AOF and the local LFC controller. So **when the AOF sends a volume** to be activated to the connecting TSO (Pcorr_aFRR), **it corresponds** exactly and explicitly **to the request of activation of the selected bids by the AOF**.



Wikipedia: An optimisation problem
*"is the problem of **finding** the **best solution from all feasible solutions**".*

The reason for using optimisation problems for balancing is **the number of borders between the TSOs** which **result in a too high complexity for a heuristic approach**

Need for optimisation problem

Using Mathematics

- The optimisation problem is formulated as an objective function and constraints, i.e.
- the "best" solution is defined implicitly
- finds the optimum

$$\min f(x), \text{ s.t.}$$
$$g(x) \leq 0$$
$$x_l \leq x \leq x_u$$

General Requirements (not exhaustive, not scientific)
A solution can be always found
The solution must be explainable
No “butterfly effect” (small change of inputs leads to big change in the result)
Speed

Linear optimisation favours all of these requirements!

General Requirements (not exhaustive, not scientific)
A solution can be always found
The solution must be explainable
No “butterfly effect” (small change of inputs leads to big change in the result)
Speed

Linear optimisation favours all of these requirements!

Optimisation concept

- As aFRR is a **real-time process** a solution of the optimisation problem is needed at least every 5 seconds
- Only a **continuous, linear optimisation** problem favors the requirements on the aFRR optimisation problem (speed, solution can be easily interpreted)

➢ Remark: No complex bids in the aFRR process (main difference to MARI and TERRE)

General Problem Formulation

Objective function	First Priority: maximise the aFRR demand satisfaction of individual LFC areas Second Priority: minimise the volume of selected standard aFRR balancing product bids Third Priority: maximise the economic surplus Fourth Priority: minimise the aFRR power interchange on each aFRR balancing border
Constraints	Sum of all Exports = Sum of all Imports
	aFRR power balance equation of each LFC area must be satisfied
	Respect the available cross-zonal capacity

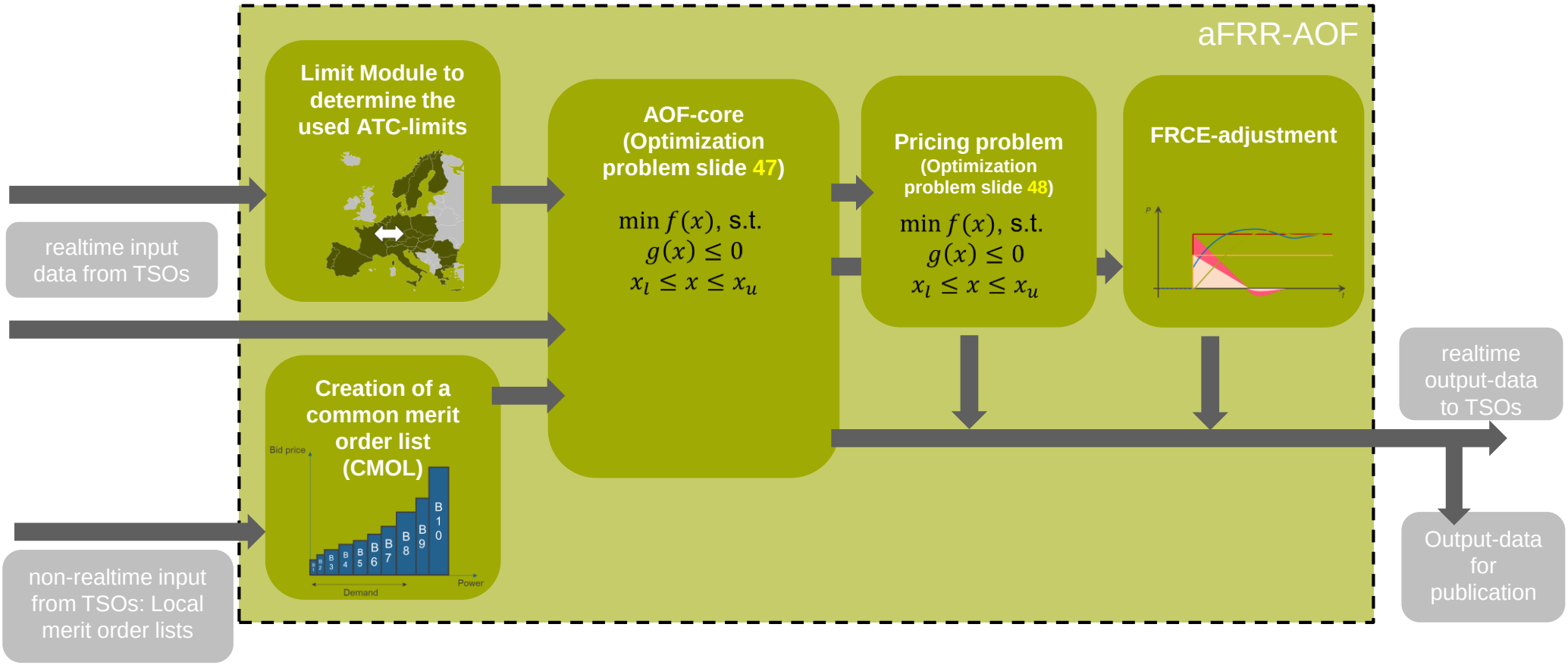
Optimisation Concepts in Context of the pricing Proposal

General Problem Formulation

Objective function	First Priority: maximise the aFRR demand satisfaction of individual LFC areas Second Priority: minimise the volume of selected standard aFRR balancing product bids
Price target	In case of activation in the LFC-area: highest price of selected bids In case of no activation in the uncongested area: mid-point between the highest price of available downward and lowest price of available upward bids
Constraints	Same price within one uncongested area
	Price must be **greater than or equal to** the highest price of upward activated bids and vice versa (no “unforeseeably accepted bids”)
	Prevent “counterintuitive flows” as far as possible

Concept of the aFRR - AOF

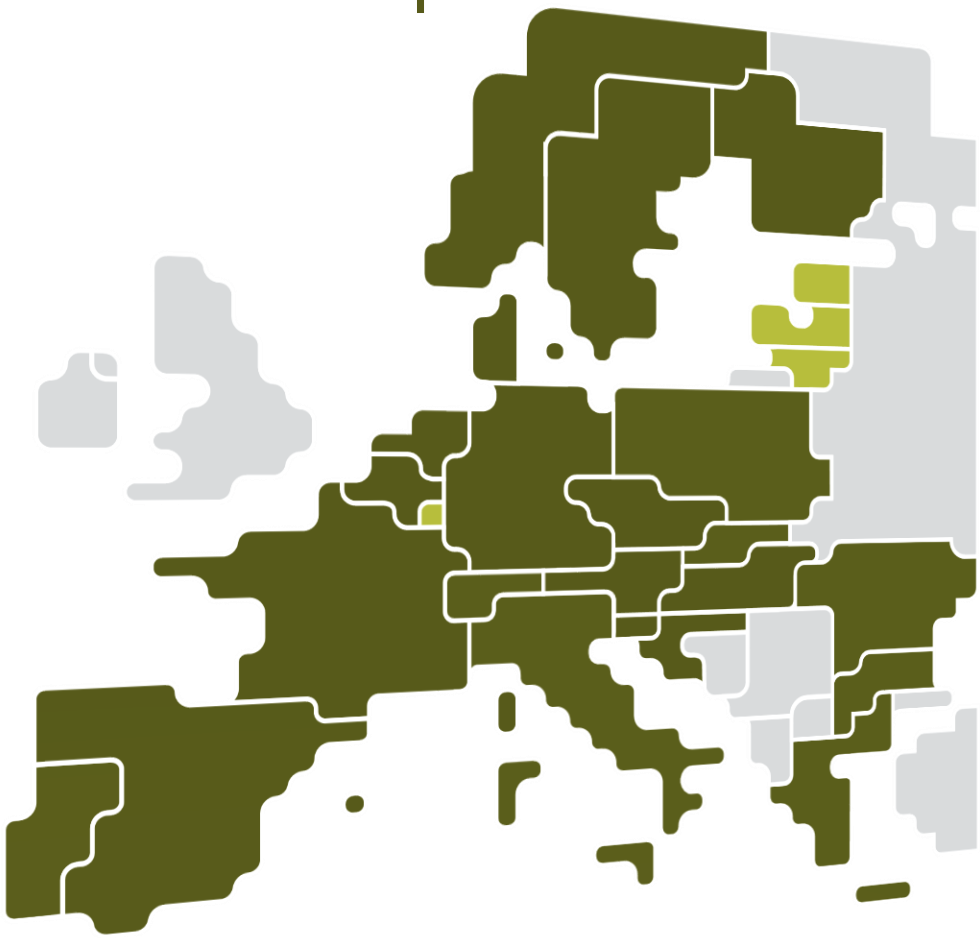
aFRR Optimisation Problem



- The optimization cycle time will be published six months before the deadline for the implementation of the aFRR-Platform
- One month before the deadline for the implementation of the aFRR-Platform the detailed (mathematical) description of the AOF algorithm will be published

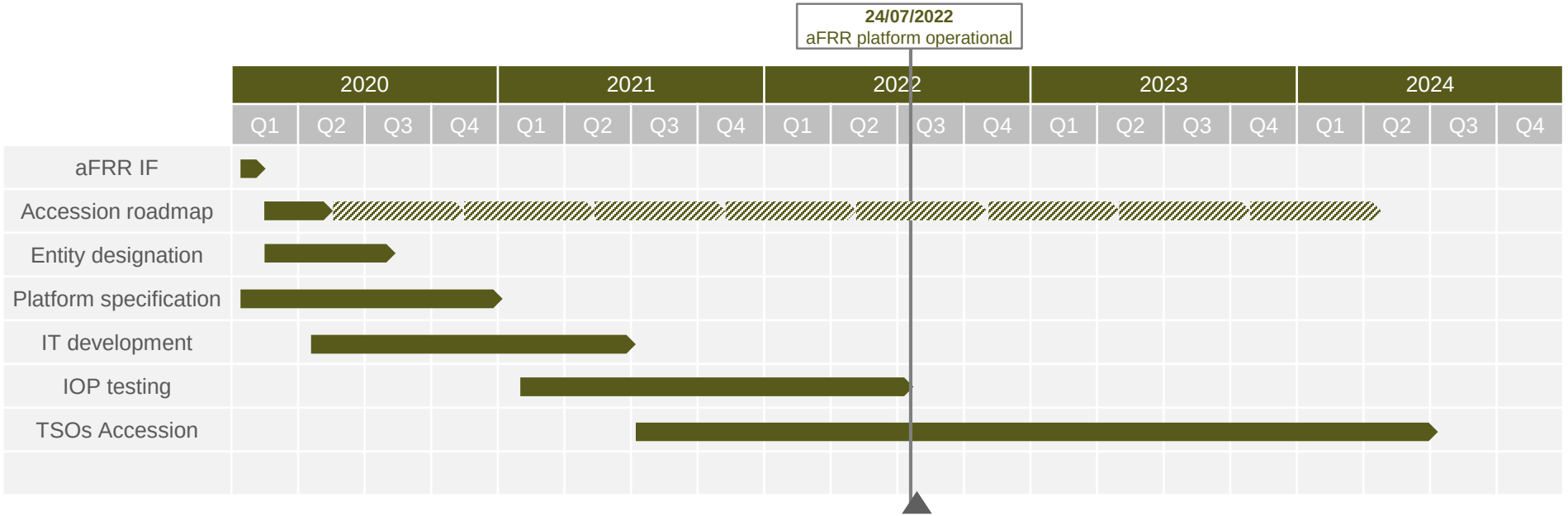
PICASSO Accession roadmap

Jiří Salavec
ČEPS



1. PICASSO planning

TSOs establish project planning until 2024 to include all PICASSO partners



2. PICASSO Accession Roadmap

Introduction

First PICASSO Acession Roadmap was published on 24 April 2020 (in accordance with aFRRIF)

PICASSO Accession Roadmap is publicly available on ENTSO-E website:
https://www.entsoe.eu/network_codes/eb/picasso/

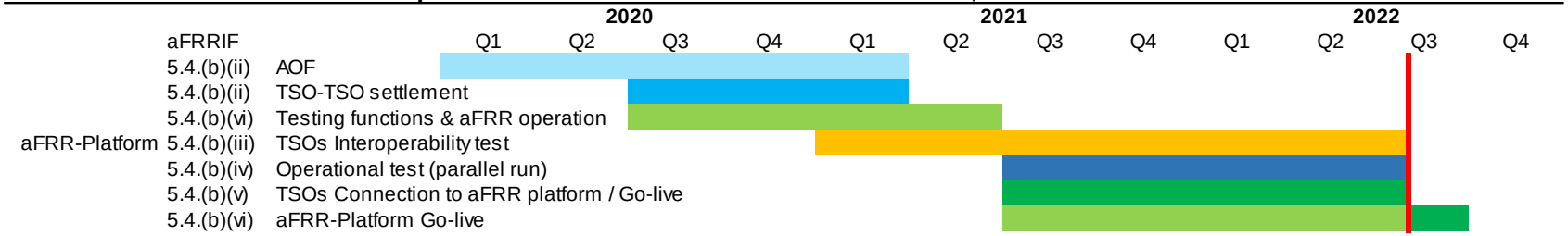
All TSOs will update Accession Roadmap every 6 months.

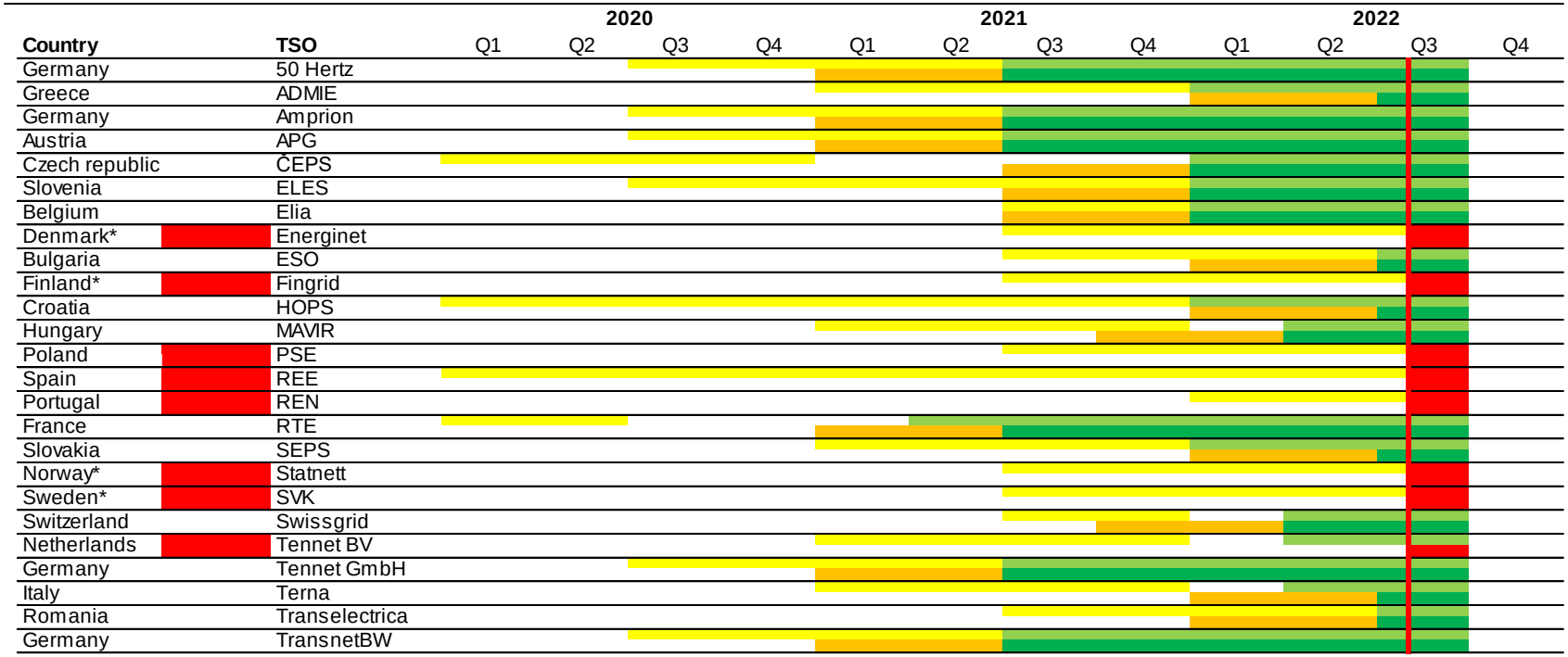
2. PICASSO Accession Roadmap

1st version (April 2020)

aFRR-Platform Accession Roadmap

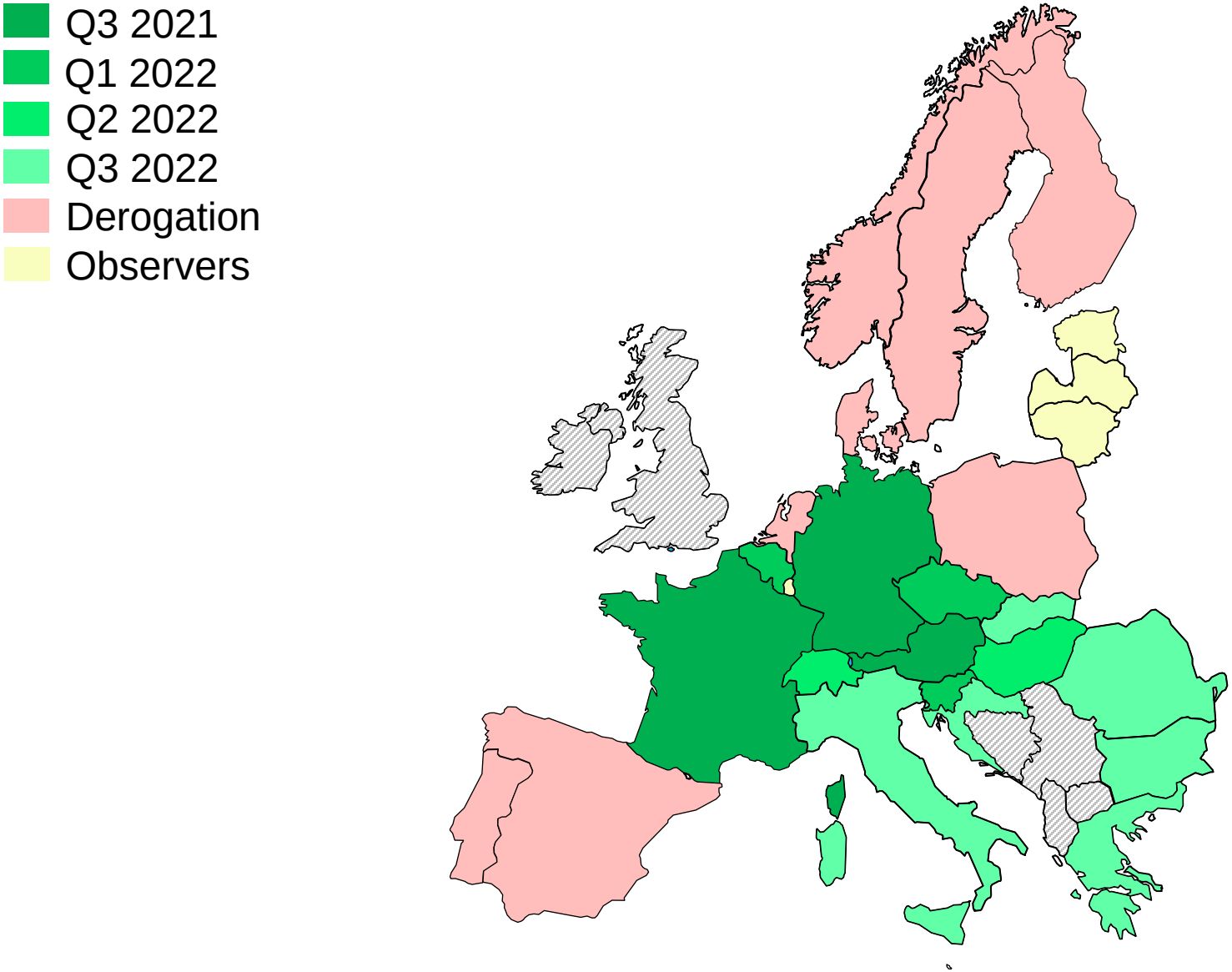
Last updated on 24/04/2020 based on latest information available.





	5.4.(b)(i)	National terms and conditions development
	5.4.(b)(i)	National terms and conditions entry info force
	5.4.(b)(iii)	Interoperability tests between TSO and aFRR-Platform
	5.4.(b)(v)	TSO connection to aFRR-platform / Go-live
	5.4.(b)(vii)	EBGL Article 62 Derogation considered / requested / granted

*) For Denmark, Finland, Norway and Sweden accession is possible Q3 2023 - Q2 2024.


Q3 2021
Q1 2022
Q2 2022
Q3 2022
Derogation
Observers

2. PICASSO Accession Roadmap

Summary

PICASSO Accession Roadmap is publicly available on ENTSO-E website:
https://www.entsoe.eu/network_codes/eb/picasso/

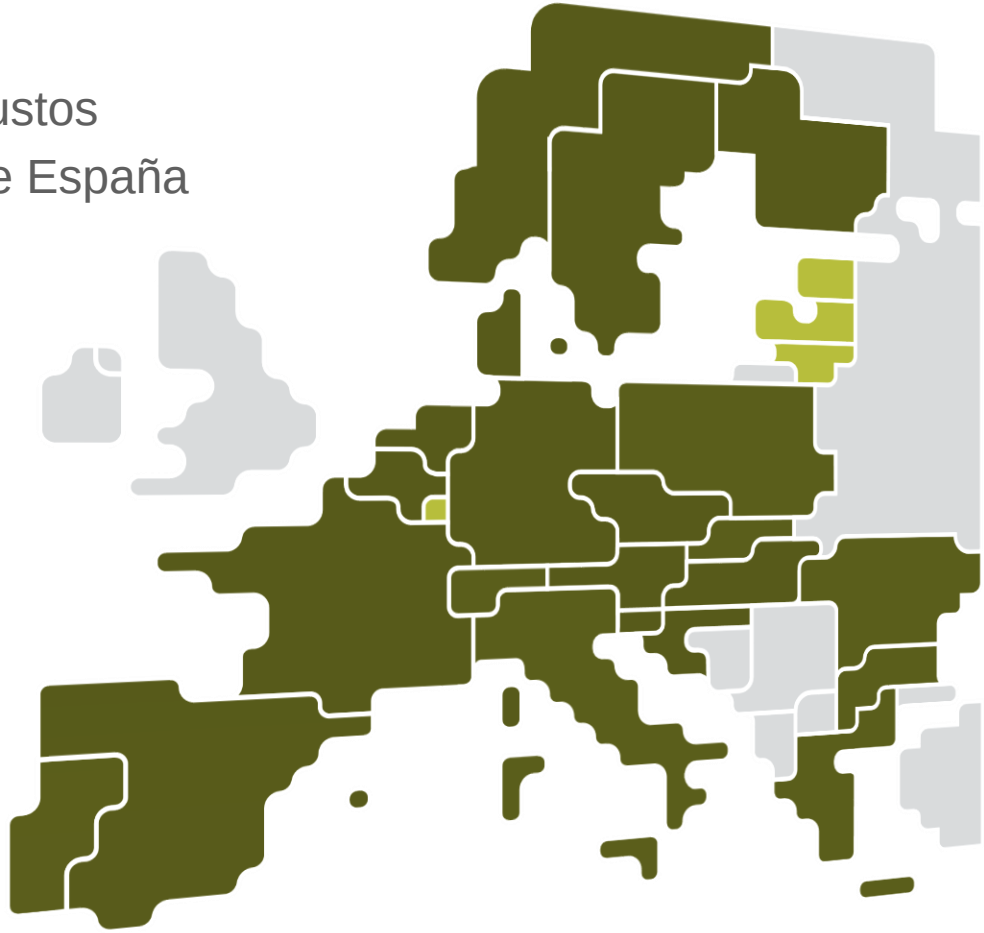
aFRR-Platform will be ready by Q2 2021

17 TSOs foresee joining before aFRRIF deadline on 24 July 2022

8 TSOs foresee asking their NRA for derogation and join in later stage

PICASSO Pricing and Settlement

Martín Pérez-Bustos
Red Eléctrica de España

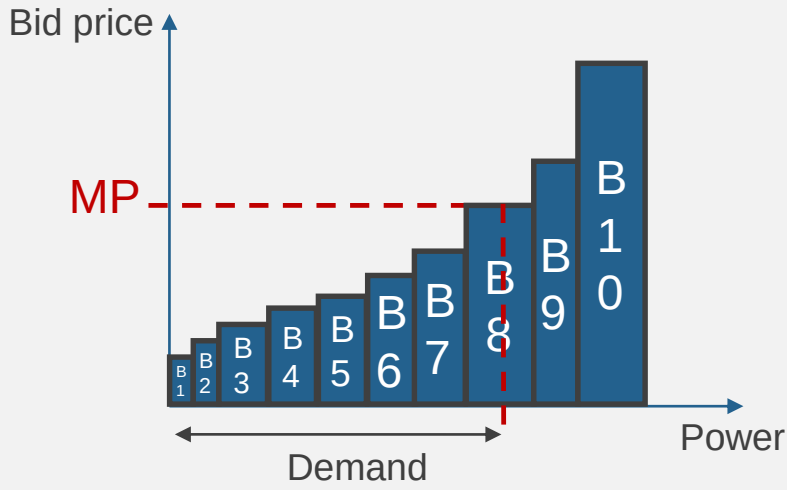


Basic Principles

Pricing for balancing energy shall be based on marginal pricing (pay-as-cleared).

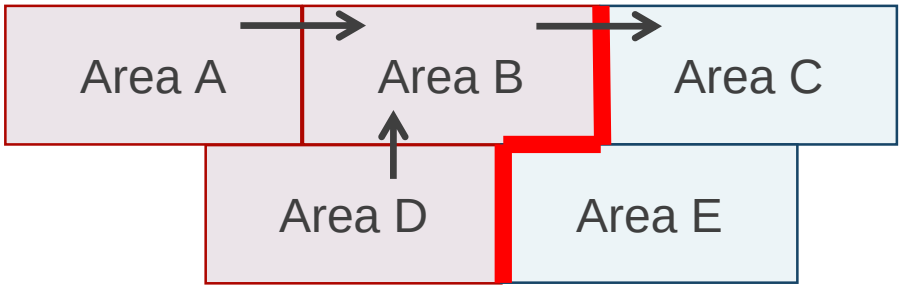
The Marginal Price (MP) represents the price of the highest price bid of a standard product which has been selected to cover the energy need for balancing purposes within a specified area.

The AOF will compute the balancing energy price per LFC area.



In 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 (principally like the day-ahead market)



Uncongested area with marginal price = MP1

Uncongested area with marginal price = MP2

Balancing energy exchange on a border

Central Price determination per optimisation cycle

Pricing principles

Pricing Proposal

- **Price determination based on central (AOF) bid selection**
- Single CBMP determination in each uncongested area per optimisation cycle of the AOF and activation direction:
  - Highest bid price of all selected positive standard aFRR balancing energy bids.
  - Lowest bid price of all selected negative standard aFRR balancing energy bids.
  - No selected bids: middle point between the lowest positive and highest negative available bids.
- Pricing signal is independent of LFC controller settings and local aFRR activation

Advantages

- Transparency, auditability and robustness of price determination methodology
- Local TSO or BSP (mis)behaviour does not affect price determination

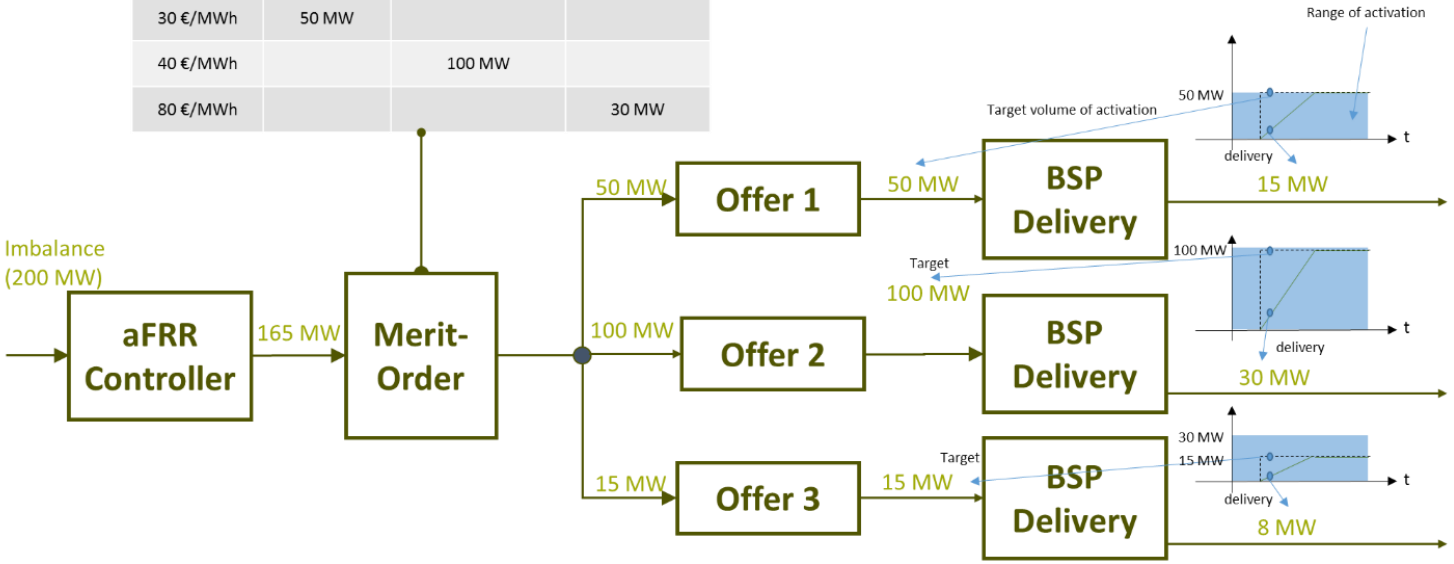
Disadvan-tages

- Additional mechanism for pricing of volumes not covered by AOF required

Aspects of aFRR activation related to pricing

aFRR controller and merit-order activation principle

Price\Volume	Offer 1	Offer 2	Offer 3
30 €/MWh	50 MW		
40 €/MWh		100 MW	
80 €/MWh			30 MW

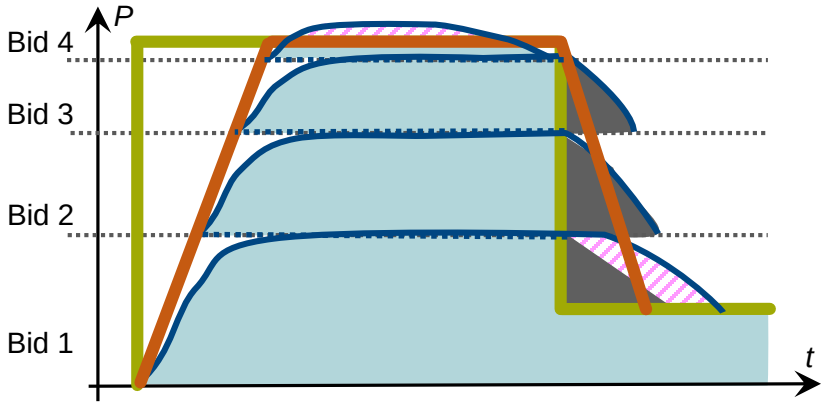


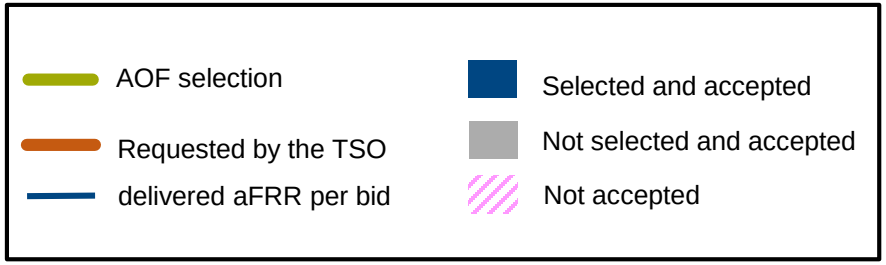
Basic principle

- Objective: regulate FRCE to zero MW
- To cover real time imbalances aFRR request signal to BSPs is adapted in each control-cycle
- Proper amount of aFRR to be activated (”target value”) differs from observed imbalances. In merit order activation, the selection of bids is performed based on ”target value”.
- Effective delivery performed by BSP is done within the required full activation time and therefore it could differ from the target value.

Aspects of aFRR activation related to pricing

AOF bid volume selection vs BSP energy delivery





Technical aspects related to pricing

- Specific dynamics of aFRR process and control demand model,
- AOF result will not correspond to the local aFRR set-points…
- … and the local set-points will not necessarily correspond to the locally delivered aFRR

This may lead to some discrepancies between the AOF selected bid volumes, the TSO requested bid volumes and the energy delivered by the BSPs.

Non-AOF volumes

Determination and pricing of non-AOF volumes

Non-AOF volumes determination

- **Non-AOF volumes:** volumes not-selected by the AOF but locally accepted.
- Potential Non-AOF volumes: deactivations, overshooting or dynamic delays
- Each TSO shall determine the Non-AOF volumes locally.

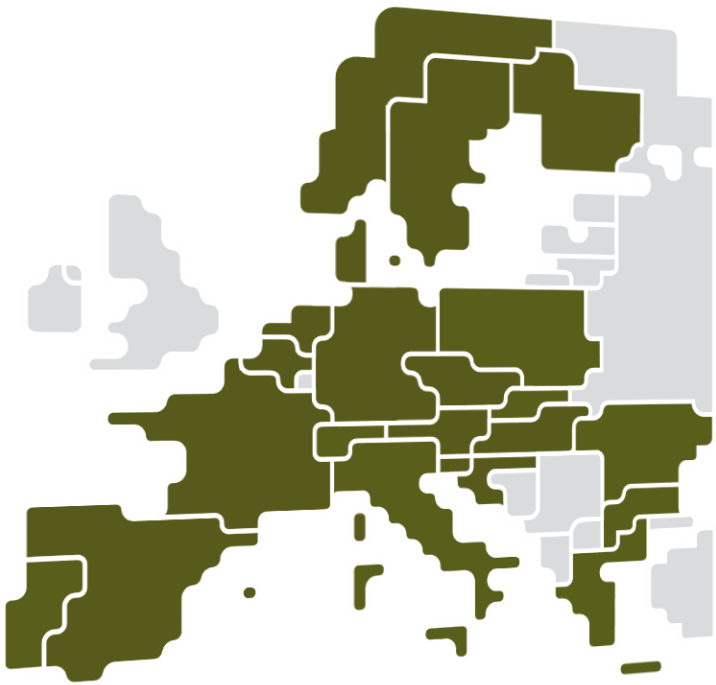
Pricing of non-AOF volumes

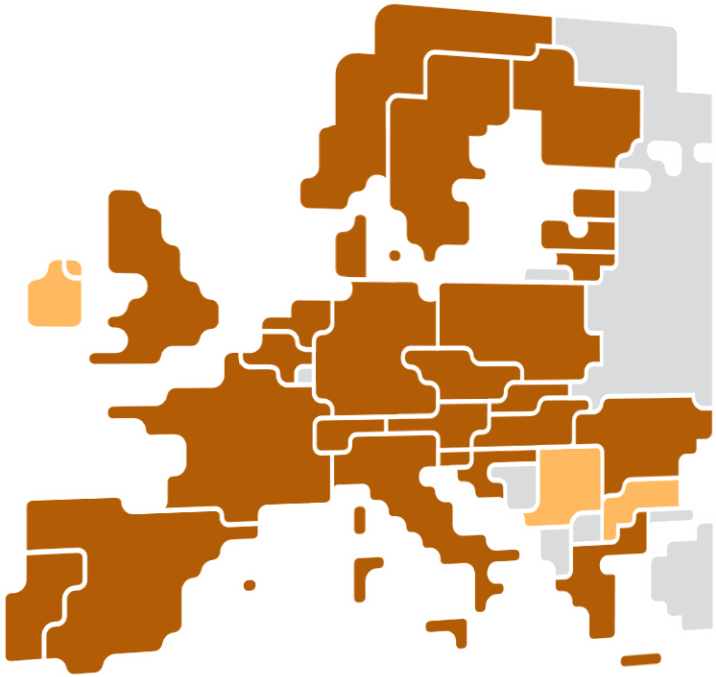
- All TSOs will use exactly the same CBMP for a given aFRR Market Time Unit (optimisation cycle).
- Each TSO shall ensure in accordance with national terms and conditions the accepted bids shall be remunerated following the principles in the Pricing Proposal:
  - Accepted bid volume for positive aFRR for each optimisation cycle is remunerated with the maximum of the CBMP and the respective bid price.
  - Accepted bid volume for negative aFRR for each optimisation cycle is remunerated with the minimum of the CBMP and the respective bid price.
- For the application of the previous points, if there is no valid bid price for the respective validity period, the latest bid price from the previous validity period will be considered.

Monitoring

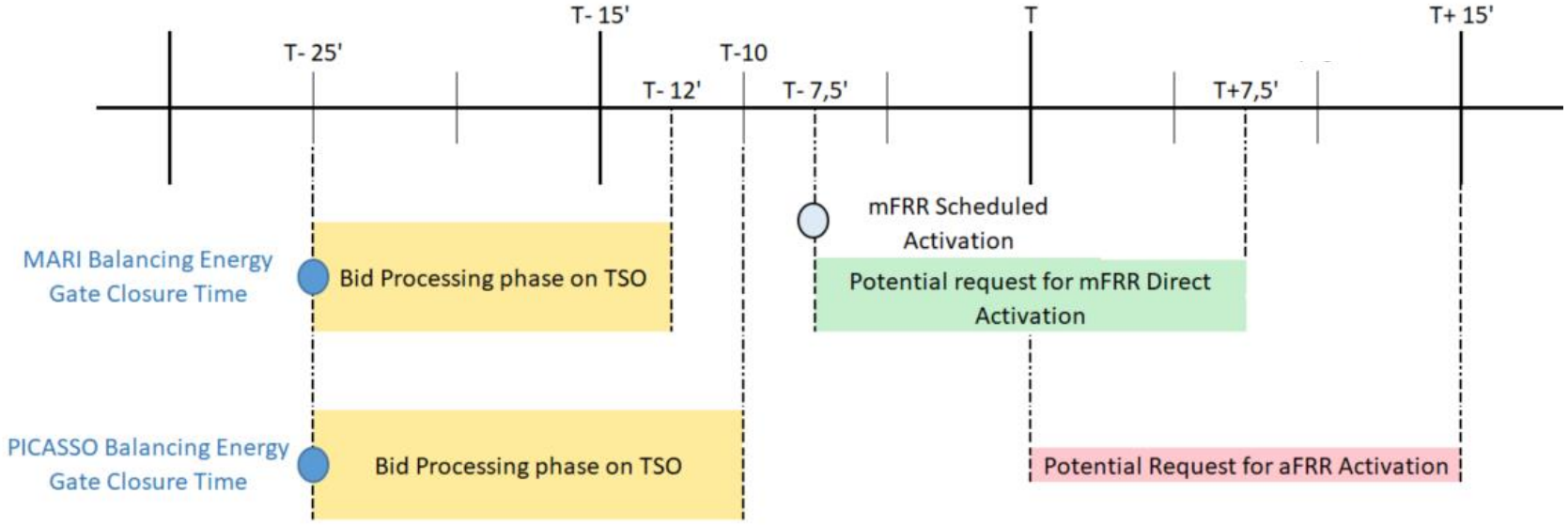
- Experience with the real platform and monitoring will allow TSOs to better assess this topic.

Gate closure planning aFRR and mFRR





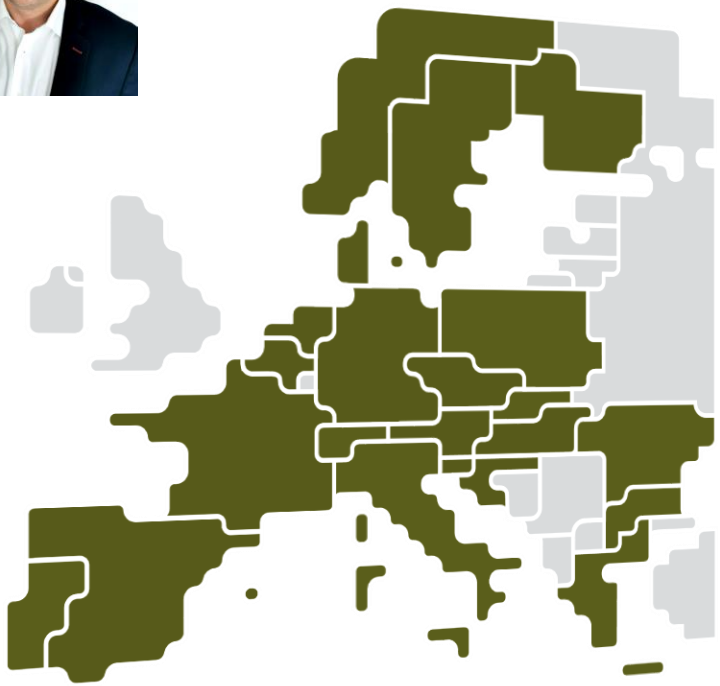
Gate Closure planning

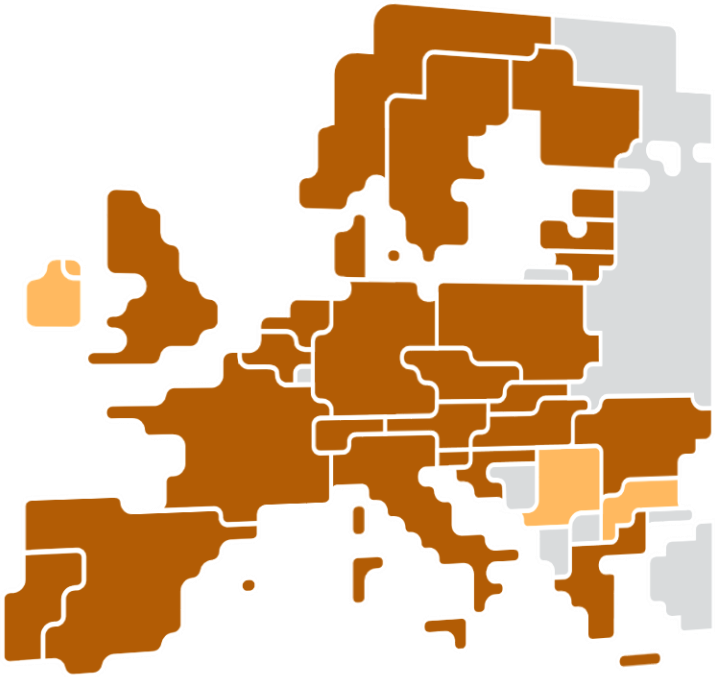


- The Balancing Energy Gate Opening Time (**BE GOT**) for MARI and PICASSO is **D-1 12:00.**
- The Balancing Energy Gate Closure Time (**BE GCT**) for MARI and PICASSO is at **T-25.**
- All **validated bids** before the BE GCT **are firm**. The bids are valid for:
  - Activation during the MTU starting in T in PICASSO
  - Scheduled Activation of MTU starting in T in MARI
  - Direct Activation, with a potential request between]T-7,5;T+7,5]
- The **input format and method** is to be defined **locally** by each TSO
  - The submitted bids by the BSPs may therefore need processing to format them in a readable format for the platform
  - The submitted bids may also be subject to **modifications by the TSO** (volume and availability status) as foreseen by the rules defined in the Terms and Conditions for BSP.
- The local TSO is responsible to provide the bids to platforms before T-12' for MARI and T-10' for PICASSO.
  - The GCT **does not apply on the availability status and volume,** which can be modified at any time.

Publishing and Reporting Obligations of MARI and PICASSO

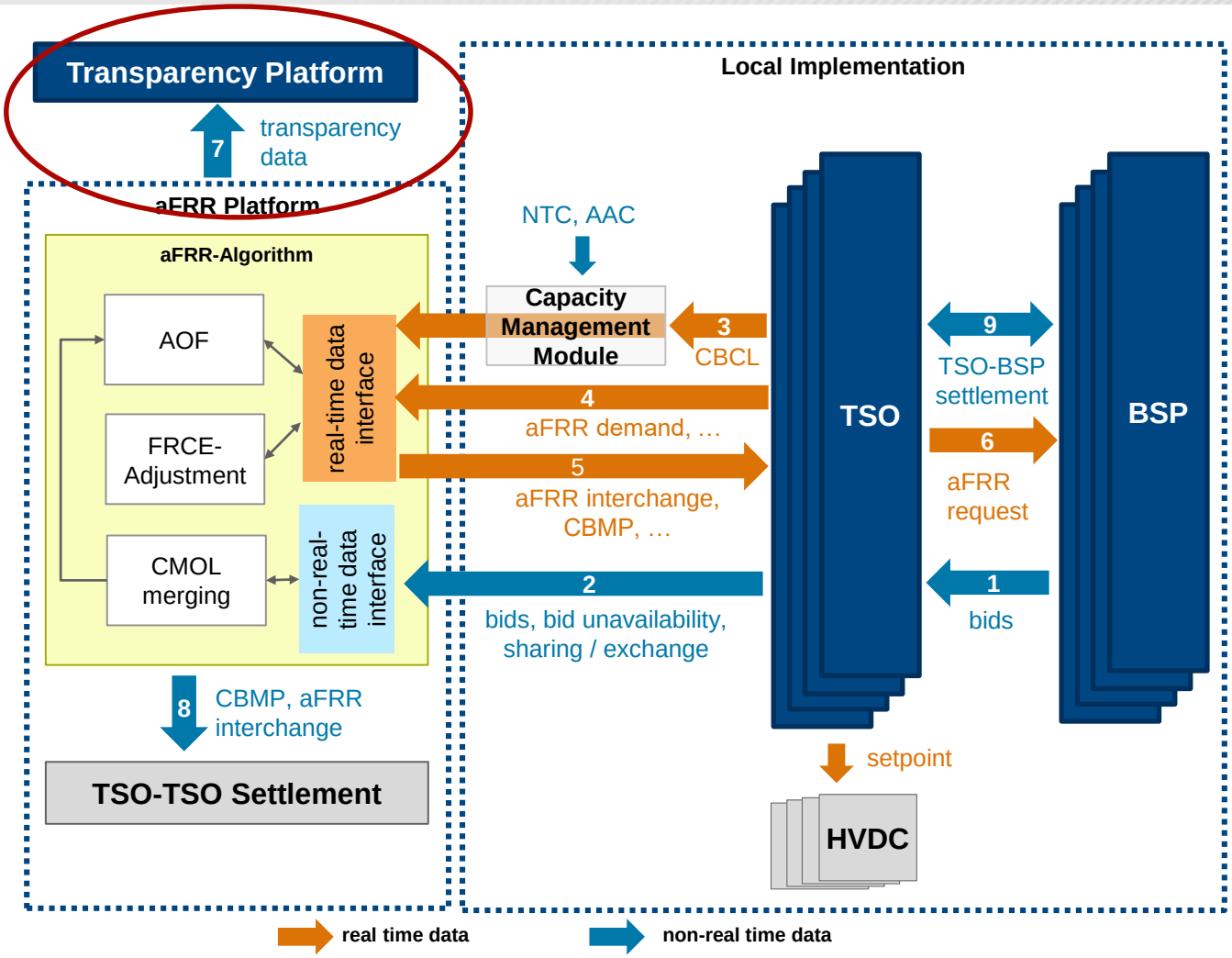
Igor Šulc
SEPS





PICASSO Platform design

PICASSO High Level Design



AOF	Activation Optimisation Function	NTC	Net Transfer Capacity
FRCE	Frequency Restoration Control Error	AAC	Already Allocated Capacities
CMOL	Common Merit Order List	CBCL	Cross-Border Capacity Limits
CBMP	Cross-Border Marginal Price	HVDC	High Voltage Direct Current

1. TSO receives bids from BSPs in their LFC area
2. TSO forwards standard aFRR balancing bids to platform
3. TSOs communicate Cross-Border Capacity Limits to Platform
4. TSOs communicate aFRR demands to platform
5. Communication of clearing results to TSO
6. Communication of aFRR request from each LFC to BSP
7. Data Publication
8. TSO-TSO settlement process and invoicing
9. TSO-BSP settlement process and invoicing

General overview of publication requirements in line with aFRR IF and mFRR IF

Obligation	Responsible	Publication	aFRR IF	mFRR IF
Elastic demand curves (MARI)	TSO*	publish on ETP**	N/A	Art. 3 (4)
Disconnection of the aFRR-platform, fall-back utilisation status as well as restoration of operation	TSO*	publish on ETP**	Art. 3 (10)	Art. 3 (11)
Publication of the volumes exchange and prices provided by the AOF	TSO*	publish on ETP**	Art. 3 (16)	Art. 3 (17)
Adjustments to capacity limits	TSO*	publish on ETP**	Art. 4 (3)(4)	Art. 4 (3)(4)
HVDC limits	TSO*	publish on ETP**	Art. 4 (5)	Art. 4(5)
Changes to bid availability	TSO*	publish on ETP**	Art. 9 (3)(6)(8)	Art 9. (3)(7)(9)
Yearly report on implementation and operation of platform	All member TSOs	on ENTSO-E website and reported to regulatory authorities	Art. 13 (1)	Art. 13 (1)
Annual public stakeholder workshop	All member TSOs	on ENTSO-E website and reported to regulatory authorities	Art. 13 (5)	Art. 13 (5)

*publication requirement is a legal obligation of TSO and where it was agreed to be publish by the aFRR/mFRR Platforms, in case of any problems with publication, TSOs are responsible for publication.
* * Publication on the ENTSO-E Transparency Platform (ETP) is selected as a target solution but this may be agreed differently.

Disconnection from the platforms, fall-back status and restoration of operation

aFRRIF Art. 3(10), mFRR Art. 3(11)

In case the AOF fails to produce outputs either due to algorithm or IT infrastructure issues, or in case a single or multiple TSOs fail to connect to the aFRR-Platform, the fall-back procedures enter into force. The TSOs shall inform the market participants without undue delay that **fall-back procedure was initiated**.

The provided information shall include:

- the reason that triggered the fall-back procedures,
- the affected TSOs and LFC areas,
- the start time with the first affected validity period and the first affected mFRR/aFRR MTU, as well as the estimated end time.

Temporary incidents longer than 5 minutes and shorter than 30 minutes shall be published by concerned TSO. – (this refers only to aFRR Platform)

Once the normal operation through the mFRR/aFRR-Platform is restored, the **Platform shall inform the market participants** specifying the start date with the first validity period and the first mFRR/aFRR MTU.

When to publish	This information shall be published as early as possible but no later than 30 minutes after end of the first mFRR/aFRR MTU of the suspension or restoration of the participation.

Publication of the volumes exchange and prices provided by the AOF

aFRRIF Art. 3(16), mFRR Art. 3 (17)

- Each participating TSO shall publish the exchange of volumes and prices provided by the AOF.
- Direct publication on the ENTSO-E Transparency Platform (ETP) was selected as a target solution.

MARI Platform (Time series: 15 min.)	**PICASSO Platform** (Time series: OC interval, published over validity period)
○ **Net position per LFC Area** (The net position of a LFC Area is its Satisfied Demand minus the Total Bids Activated in this LFC Area, and per definition it is the exchange of volumes related to this LFC Area which could be positive or negative), ○ **CBMP per MTU for Scheduled Activation**, per LFC Area, ○ **CBMP per MTU for Direct Activation** (differentiation between negative and positive direction), per LFC Area.	○ Publication of **exchange of volumes** based on the output of the AOF for every validity period, ○ and **CBMP per MTU** for aFRR balancing energy activation,

When to publish	As soon a possible and no later than 30 minutes after the relevant mFRR/ aFRR MTU.

Adjustments to capacity limits

aFRRIF Art. 4(3)(4), mFRRIF Art. 4(3)(4)

According to Art. 4 (4)	The participating or affected TSOs imposing adjustments to capacity limits (TSO may require adjustments of ATC) due to: • operational security; • power interchange with respect to operational security limits; • performance of real-time operational security analysis by participating and affected TSOs. **TSOs imposing adjustments to capacity limits shall publish the request with a justification for these limitations.**

- ***A clear definition of affected TSO is necessary.***
- All participating TSOs will establish the implementation of operational procedures to ensure the operational security .

According to Art. 4 (3)	The adjustments to capacity limits may also be applied to mFRR/aFRR balancing borders that do not correspond to a bidding zone border. In normal cases the capacity after ID will be used for balancing markets. When TSO changes the initial cross-zonal CBCL the information **will be published by the respective TSO on ETP** (working assumption).
When to publish	This information shall be published **no later than 30 minutes after** the end of the relevant mFRR MTU/ aFRR validity period in which the additional limitations have been requested.

Permanent limitations on HVDC

aFRRIF Art. 4(5), mFRRIF Art. 4(5)

The adjustments of cross-zonal capacities imposed:

1. due to technical inability to facilitate cross-zonal manual/automatic frequency restoration power interchange on HVDC interconnectors,
2. and/or with the aim to ensure:
   a) the stability of the FCP of the synchronous area or synchronous areas involved in the imbalance netting process;
   b) the stability of the FCP of the synchronous area or synchronous areas involved in the cross-border FRR activation process;
   c) the stability of the FRP and the RRP of each LFC area operated by participating or affected TSOs;
   d) the operational stability;

Relevant TSOs may disable any exchange on mFRR/aFRR balancing border that is constituted only of HVDC interconnectors.

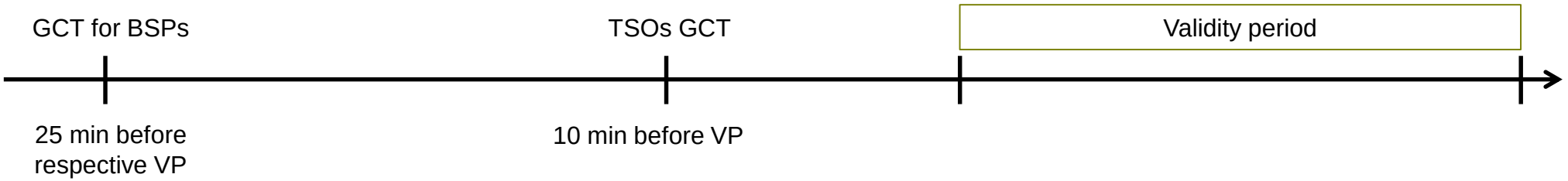
The limitation of a given mFRR/aFRR balancing border is allowed when:

- duly justified by the relevant TSOs concerned by the mFRR/aFRR balancing border;
- the concerned regulatory authorities is notified of this limitation;
- the technical justification is published by the concerned TSOs.

Since these restrictions are permanent, they should not have to be repeated every 15 minutes through platforms.
These restrictions should be published directly by the relevant TSOs, through their established reporting

Changes to bid availability

aFRRIF art. 9(3)(6)(8) mFRR art. 9(3)(7)(9)



Any time before the TSO energy bid submission gate closure time, the participating TSO may modify the bids in accordance the EBGL Regulation.	Only when new information becomes available to a participating TSO that affects the possibility to activate the standard aFRR/mFRR balancing energy product bids, the participating TSO may apply these changes after the TSO GCT. All TSOs shall define the latest possible time until such changes of bids shall be allowed.

Modification to the bids shall be limited to the following two cases:

a) where lack of changes of bids would lead to violations of operational security or specifically frequency limits,
b) where the bid is conditional on the bids submitted outside the aFRR-Platform (changed at the request of the BSP).

The reasons for bids changes shall include at least:**

a) the party requesting the change (TSO, DSO or a BSP);
b) the name of the TSO or the DSO and the exact operational security limit expected to be violated;
c) in case of changes requested by a TSO:
    i. in case of thermal limits the concerned network element(s); and
    ii. in case of frequency limits, whether the expected violation would be caused by insufficiency of required reserve capacity or by technical unavailability of specific reserve providing unit(s); → relevant for MARI
d) if requested by a BSP, the information that the bid has been modified due to activation of conditional bid.

When to publish	The information shall become available to all other TSOs, communicated to the affected BSP(s) by 30 minutes after the end of the relevant mFRR MTU / validity period aFRR

The Common Report according to Article 13(1) of aFRR IF

a) the implementation progress and roadmap,

b) the amount of aFRR balancing energy requested by each participating TSO,
c) the frequency and volume of deviations between the activation of bids by TSOs and the selection of bids by the AOF,
d) the impact on the economic surplus of minimising the volume of selected aFRR balancing energy product bids,
e) aggregated information on unavailable bids,
f) the efficiency of the pricing method ,

g) the availability of cross-zonal capacity,
h) survey results;

The Common Report according to Article 13(1) of mFRR IF

a) the implementation progress and roadmap,
b) the usage of elastic mFRR demand,
c) the amount of aFRR balancing energy requested by each participating TSO,
d) the frequency and volume of deviations between the activation of bids by TSOs and the selection of bids by the AOF,
e) the total volume of paradoxically rejected bids,

f) aggregated information on unavailable bids,
g) the impact of scheduled counter-activations on balancing energy prices,
h) the availability of cross-zonal capacity,
i) survey results;