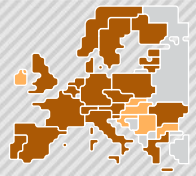
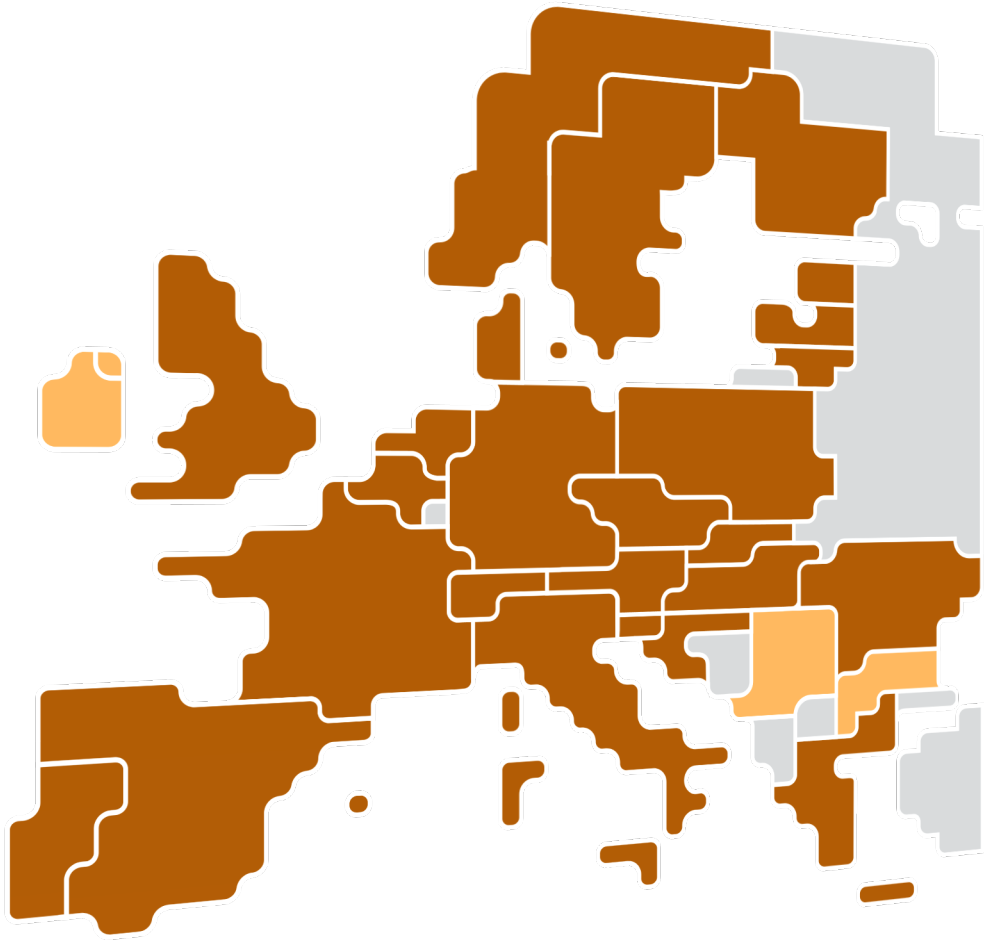
1. Welcome and introduction

Agenda

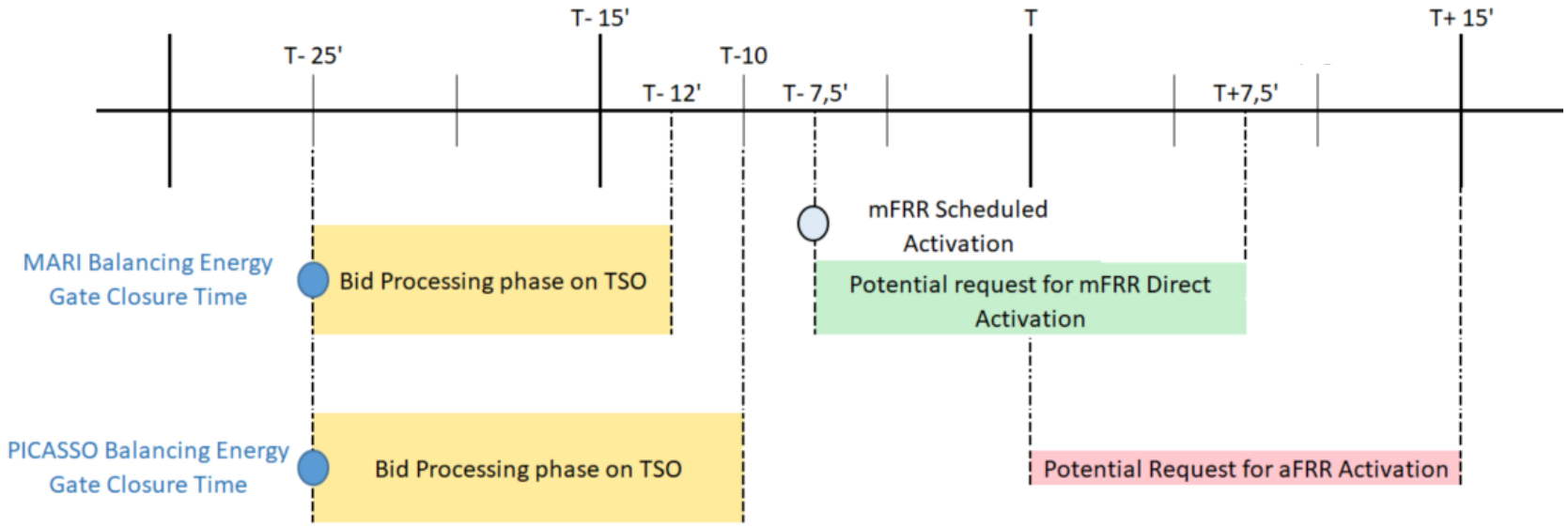


	SUBJECT	WHO	TIMING
1	**Welcome & Introduction**		
2	**Gate closure planning aFRR and mFRR**		
3	**mFRR Process**		
4	**mFRR Balancing Energy Product**		
5	**MARI Bidding design**		
6	**MARI Algorithm (AOF)**		
7	**mFRR Pricing**		
8	**MARI Project timing**		
9	**Closure**		

Gate closure planning aFRR and mFRR

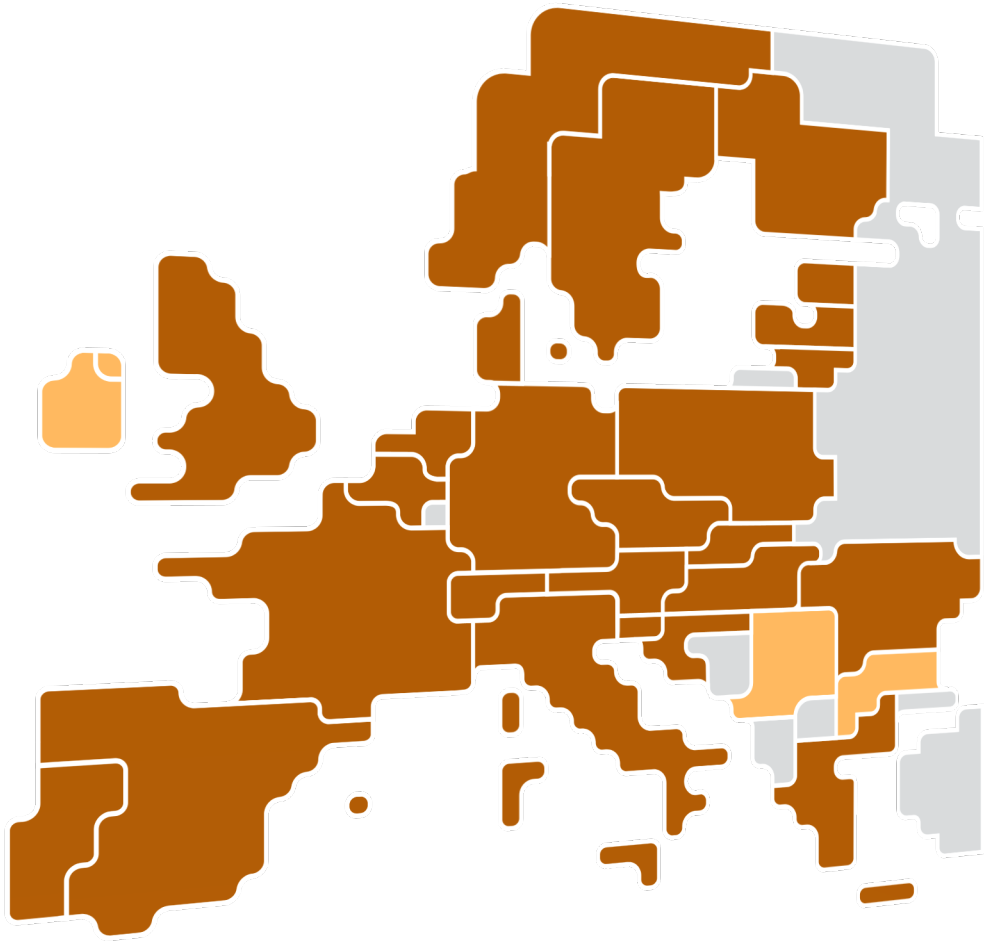


Gate Closure planning



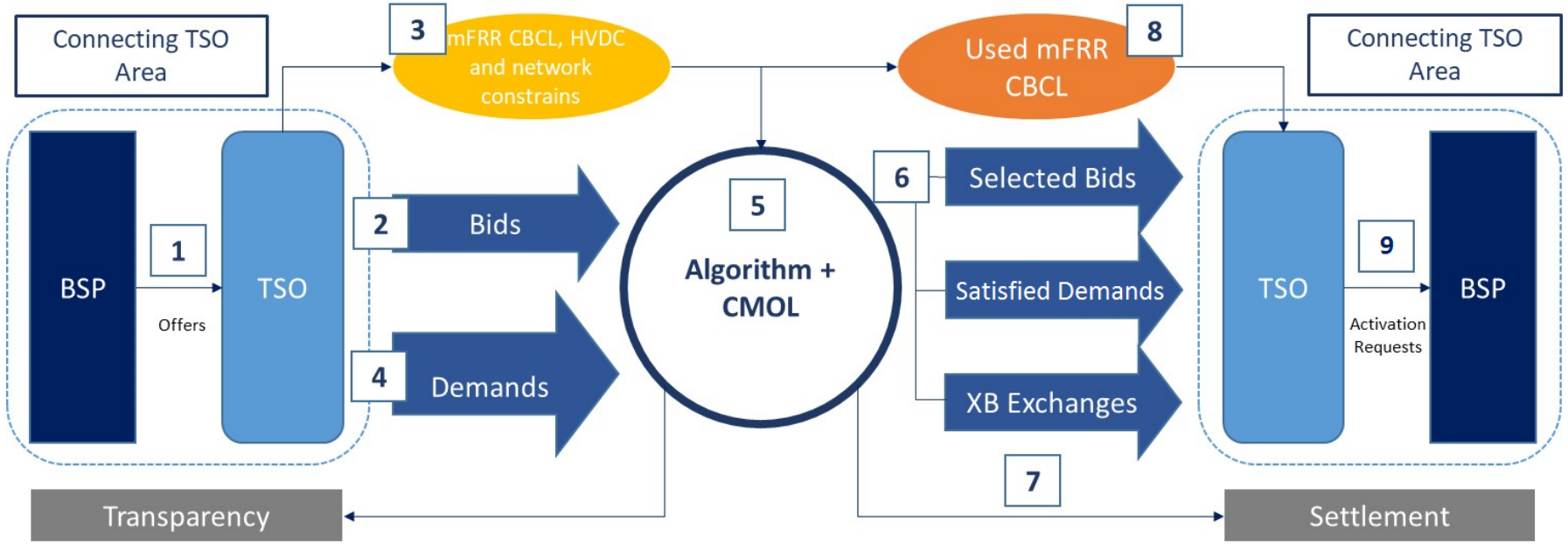
- The Balancing Energy Gate Opening Time (**BE GOT**) for MARI and PICASSO is **D-1 12:00.**
- The Balancing Energy Gate Closure Time (**BE GCT**) for MARI and PICASSO is at **T-25.**
- All **validated bids** before the BE GCT **are firm**. The bids are valid for:
  - Activation during the MTU starting 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.

mFRR Process



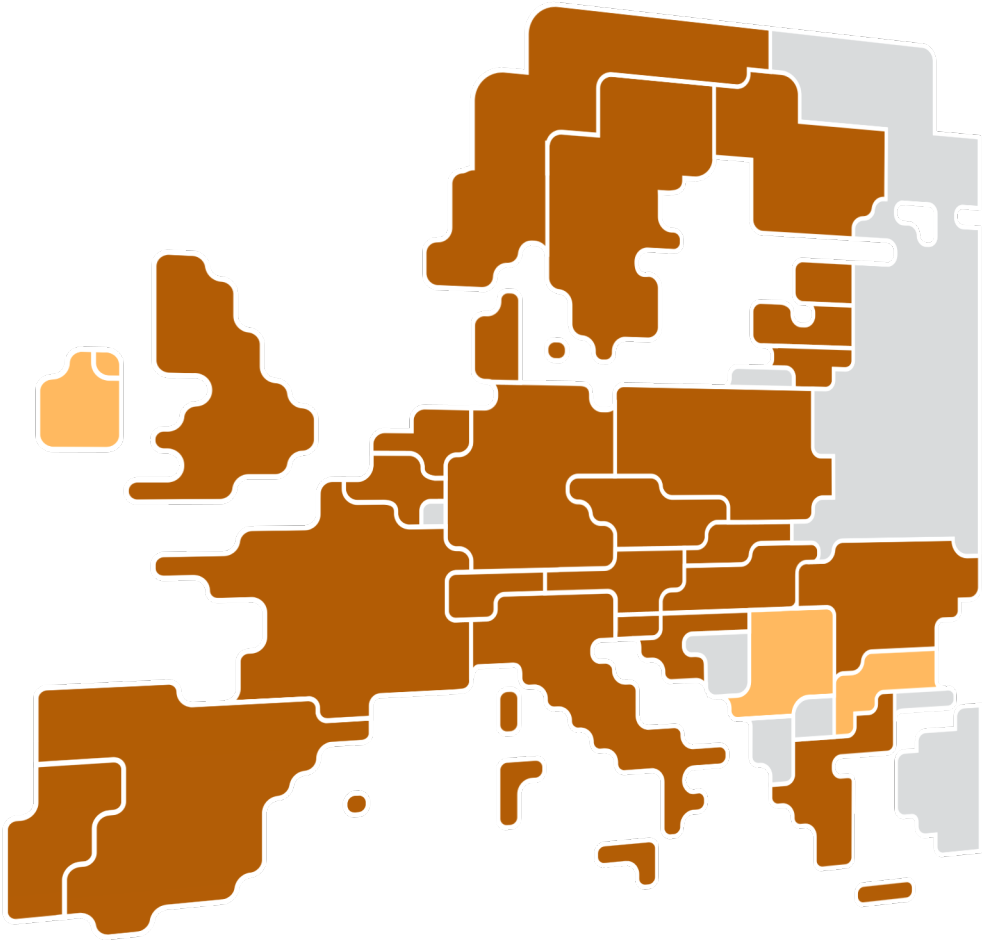
The mFRR process

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



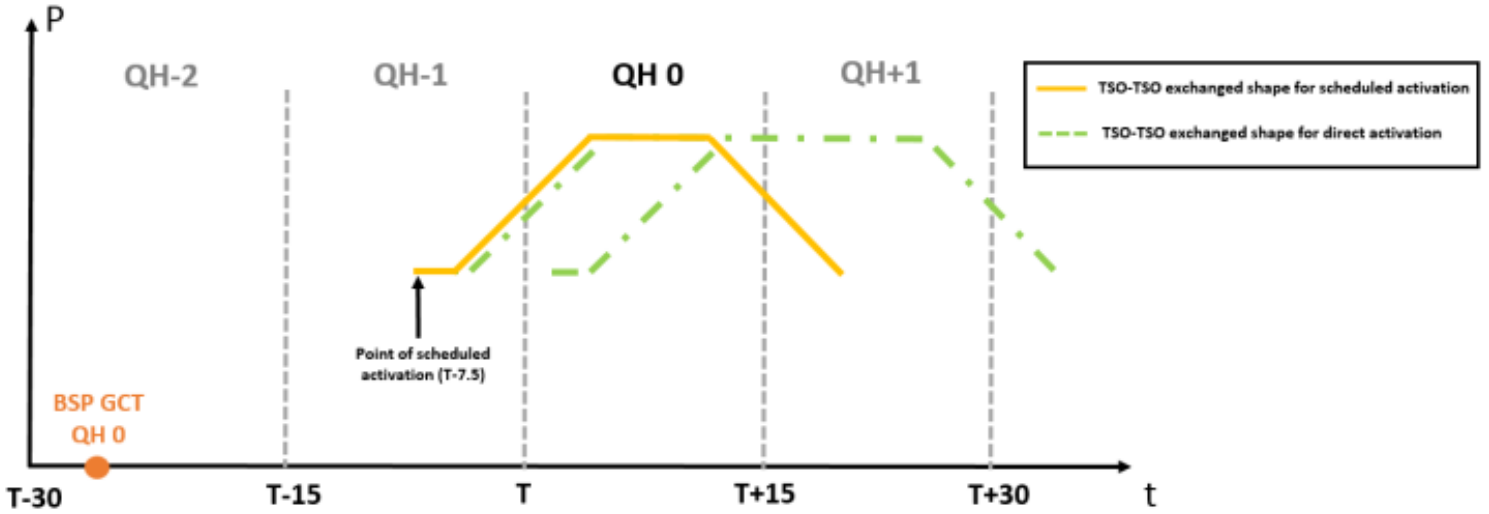
mFRR Balancing Energy Product

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)

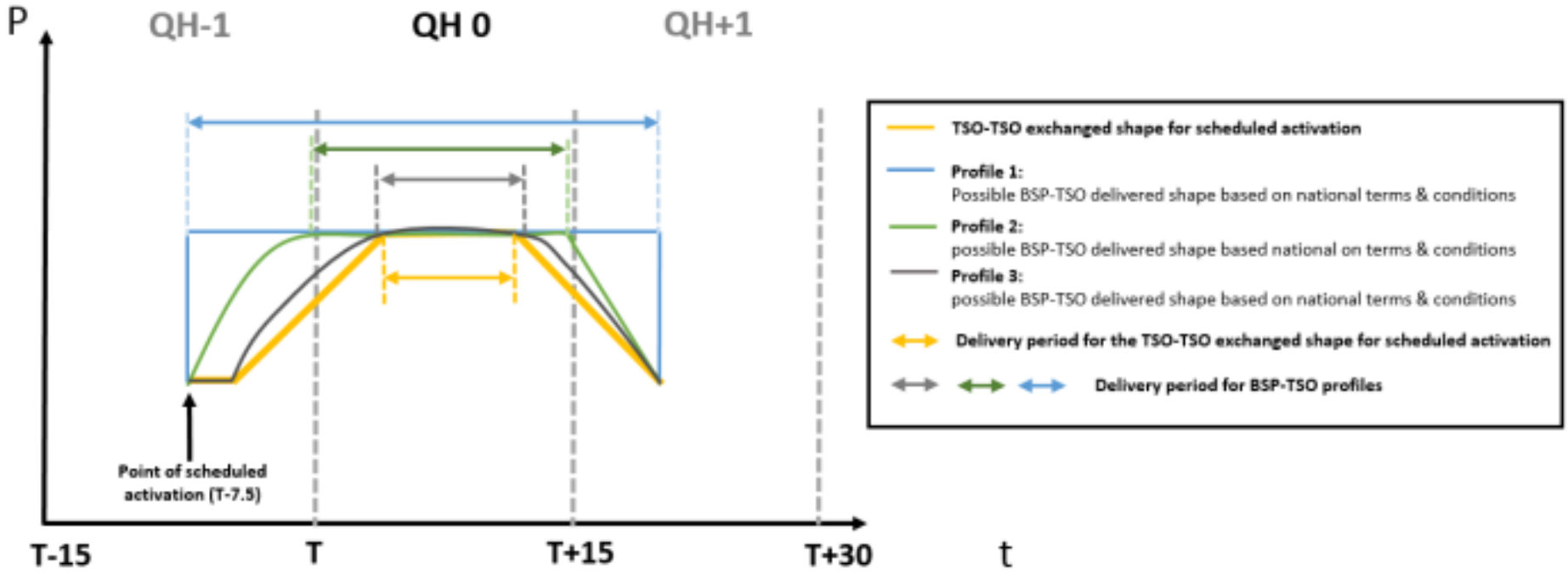
- *Direct Activation* will **run on-demand**, with delivery from the **remainder of one quarter hour and to the end of the subsequent quarter hour**.
- TSO – TSO delivery shape* (*Direct Activation* in QH0):
  - 12.5 minutes Full Activation Time, consisting of
    - 2.5 minutes preparation time
    - 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)



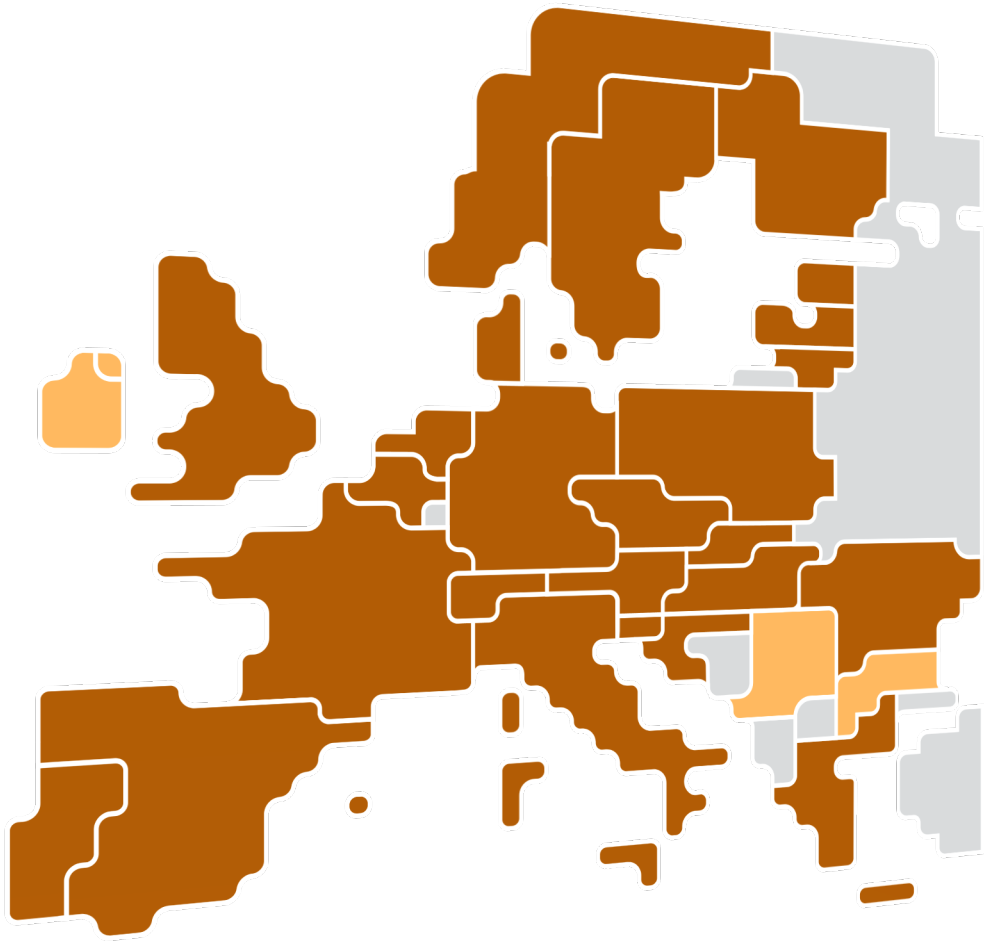
*TSO – BSP delivery shape will be defined in the national terms and conditions

BSP-TSO Delivered Shape

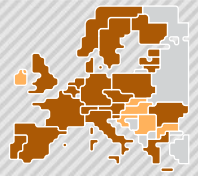
- The *'BSP-TSO delivered shape'* refers to the actual delivery/withdrawal of certain units.
- Given the variety of **intrinsic differences** between local markets, TSOs management of the system, and pre-qualification requirements **defined in the terms and conditions for BSPs**, bid characteristics 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**.

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

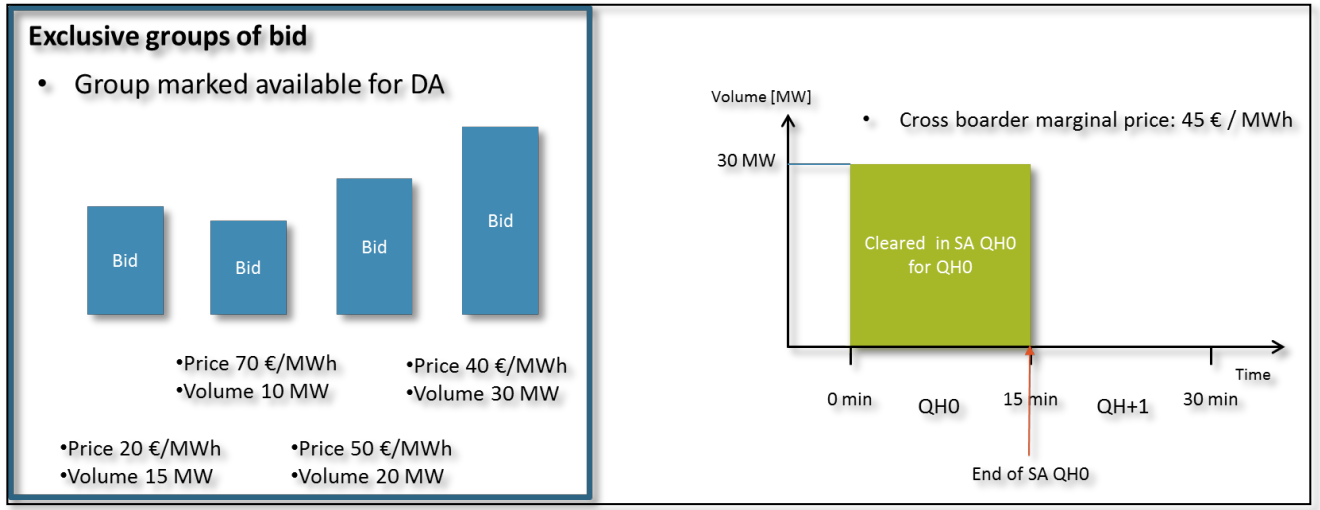
Depending of the size of the minimum offered Volume (parameter z); the following types of bid can be modelled.

	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



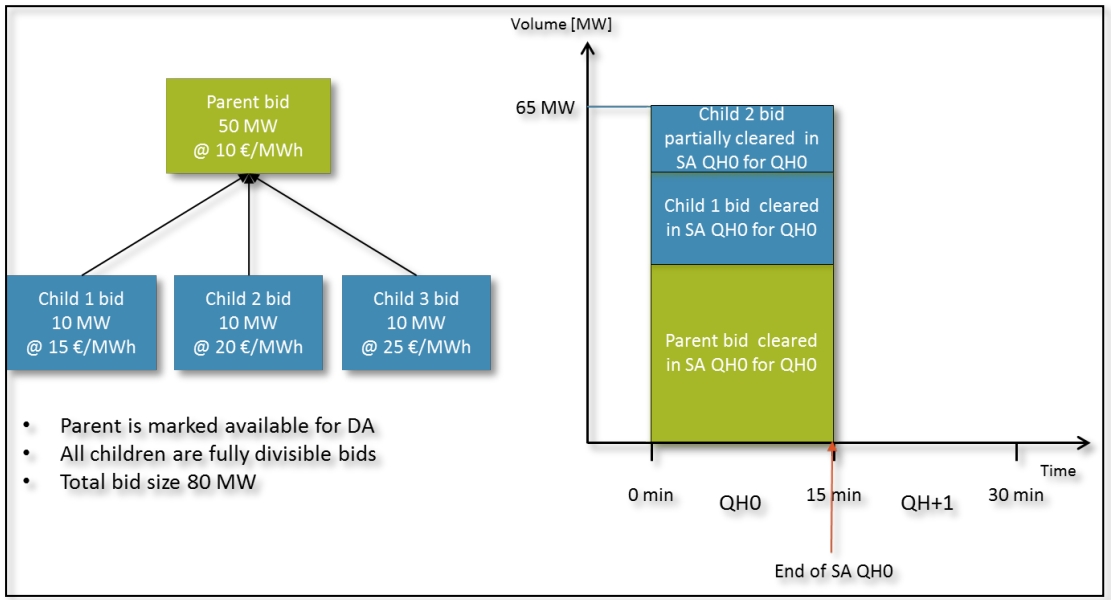
Exclusive bids intend to give to BSPs the **opportunity to model their costs**:

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.

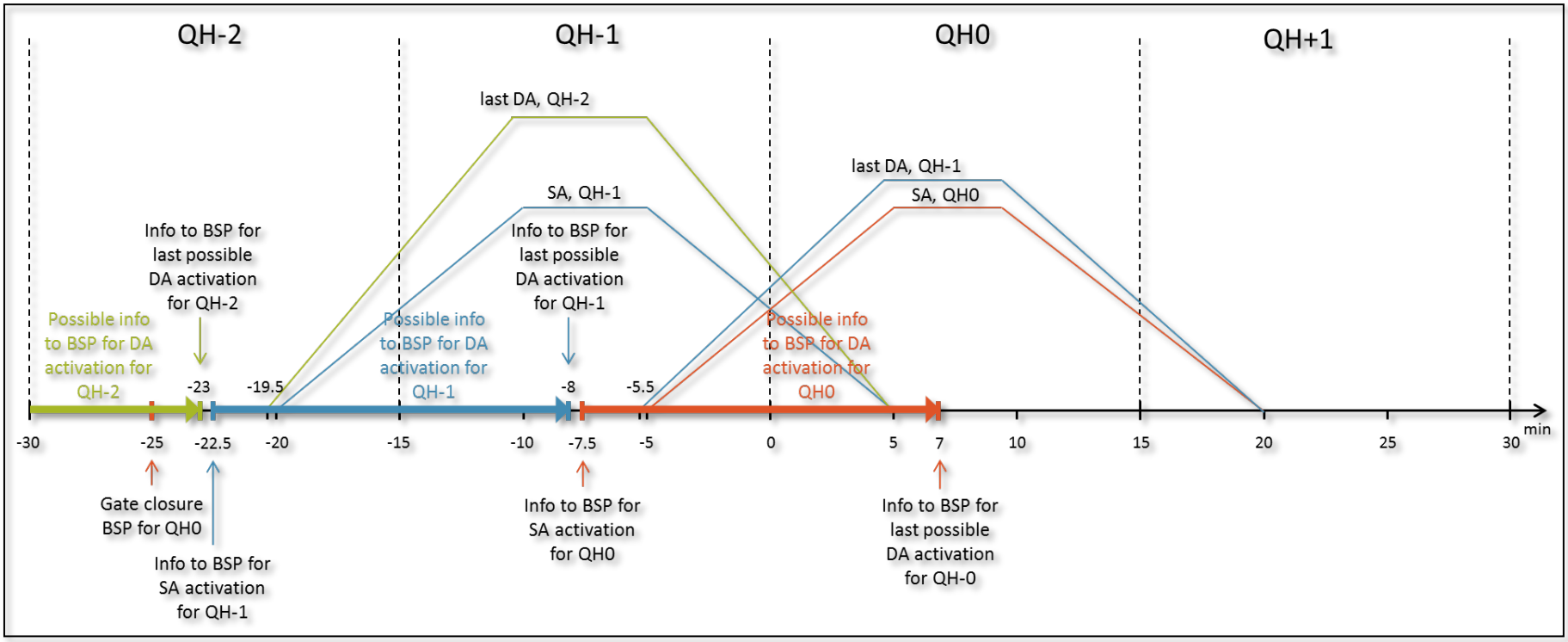
- If a downward multipart bid is accepted – **all associated bids with higher price must also be accepted**
- If an upward multipart bid is accepted – **all associated bids with lower price must also be accepted**
- If **any component / any bid** in the multi-part bid **is accepted in SA**, **none**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

Bidding Design

Linkage of bids

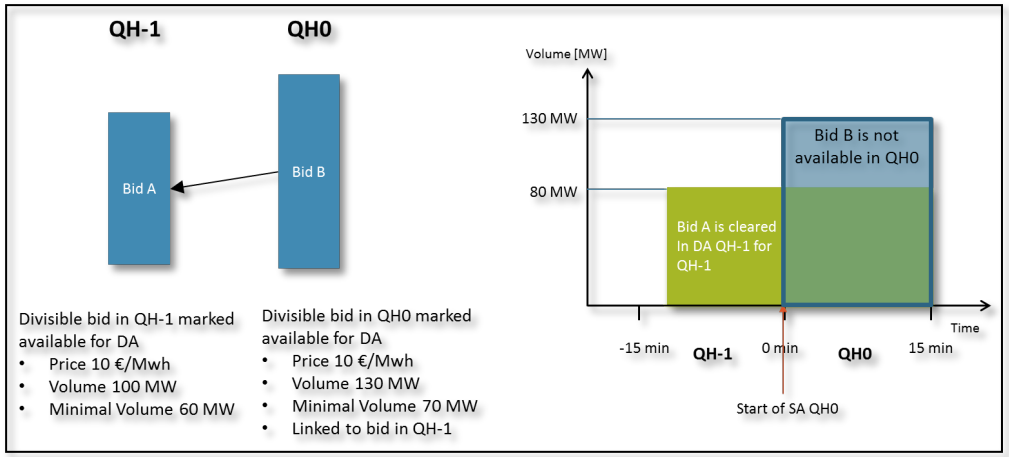
- BSP can either link bids together with a **technical link** or with a **conditional link**
- TSOs are still investigating the interaction between technical and conditional linking, **the content presented is subject to change and** may be adapted by the TSO.
- Technical and conditional linking **are 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

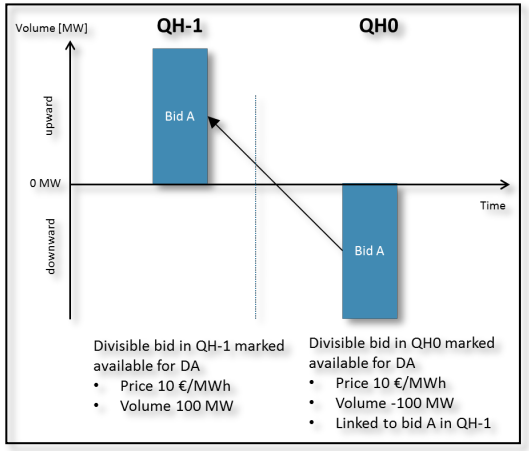
Technical linkage is the linkage of two bids (simple or complex) in two or three subsequent quarter hours. Bids must be identifiable with a unique ID and it remains the responsibility of BSPs to correctly identify their bids, in order to avoid unfeasible activations (e.g. double activation of the same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



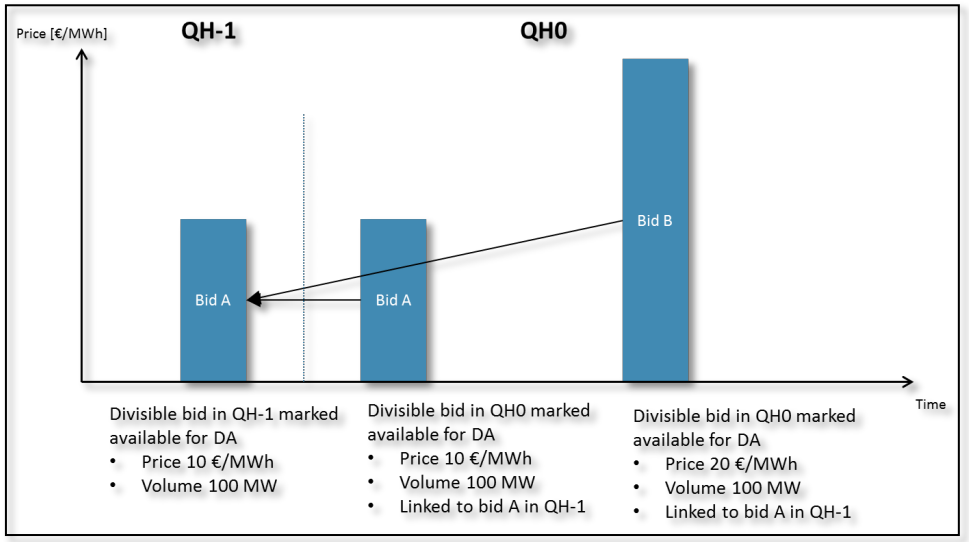
It defines if a bid in QH0 is available for clearing if the bid in the QH-1 **was not activated in DA**. Technical linkage **avoids the activation of the same** balancing **resource** twice.

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.

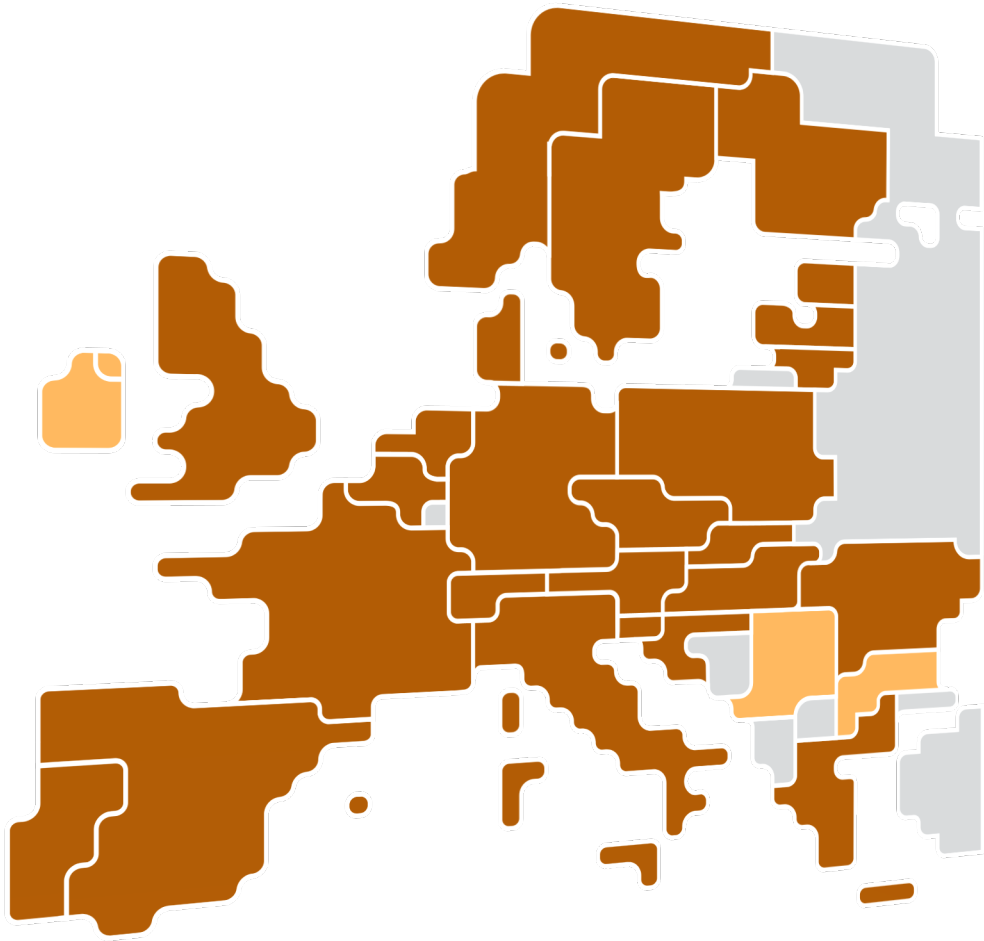


- Conditional linkage is needed because the BSP do not know at gate closing QH0, if their bid in QH-2 was activated in DA or if their bid in QH-1 was activated in SA or DA.
- **Due to constraint** a bid in QH0 might or might not be available for clearing if bid in QH-1 was activated in SA or bid in QH-2 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:

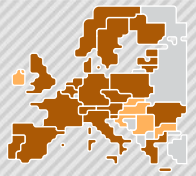
- If bid A in QH-1 is activated in SA, bid B is not available in QH0 and bid A is available in QH0
- If bid A in QH-1 is not activated, bid B is available in QH0 and bid A is not available in QH0
- If bid A in QH-2 is activated in DA, bid B is not available in QH0 and bid A is available in QH0
- If bid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

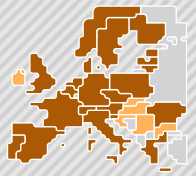
- ✓ Direct and scheduled activations use the same AOF with different input data. Updates will be performed taken into account previous results.
  - ✓ For the SA, **all bids are considered.**
  - ✓ For the DA, **only upward or downward CMOL is used.**

- ✓ 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

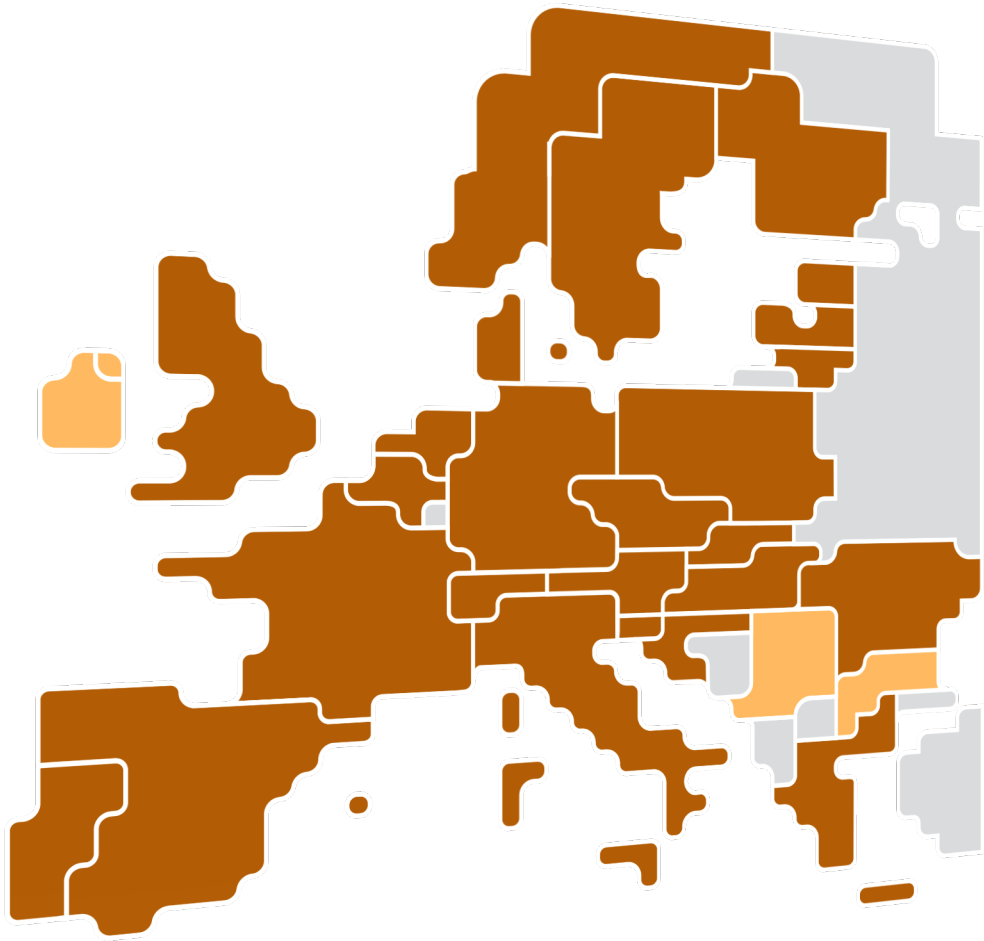
- **Cross-border marginal prices (CBMPs)**
- **Satisfied demands**
- Net position of each scheduling area
- Cross-border flows in the interconnectors (AC and HVDC).
- Remaining cross-border capacity
- **Selected bids (and volume)**
- Execution statistics

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****

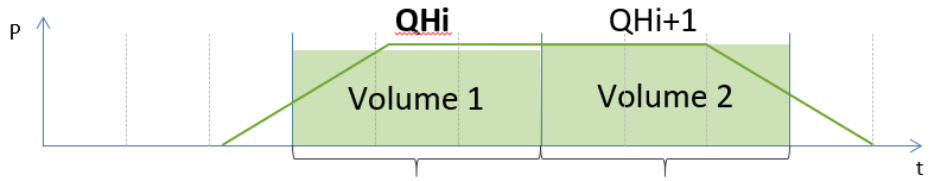
* currently pending further investigation
** behavior of the AOF in case of DFRs is under analysis

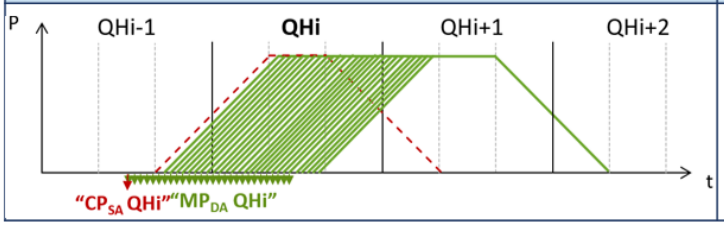
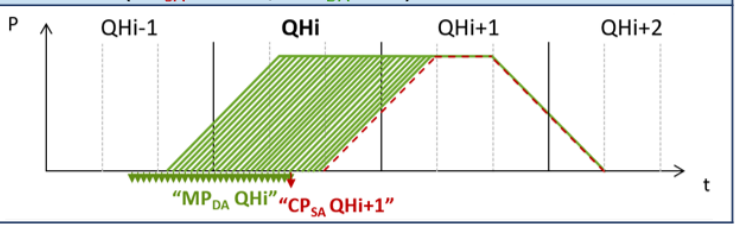
mFRR Pricing



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

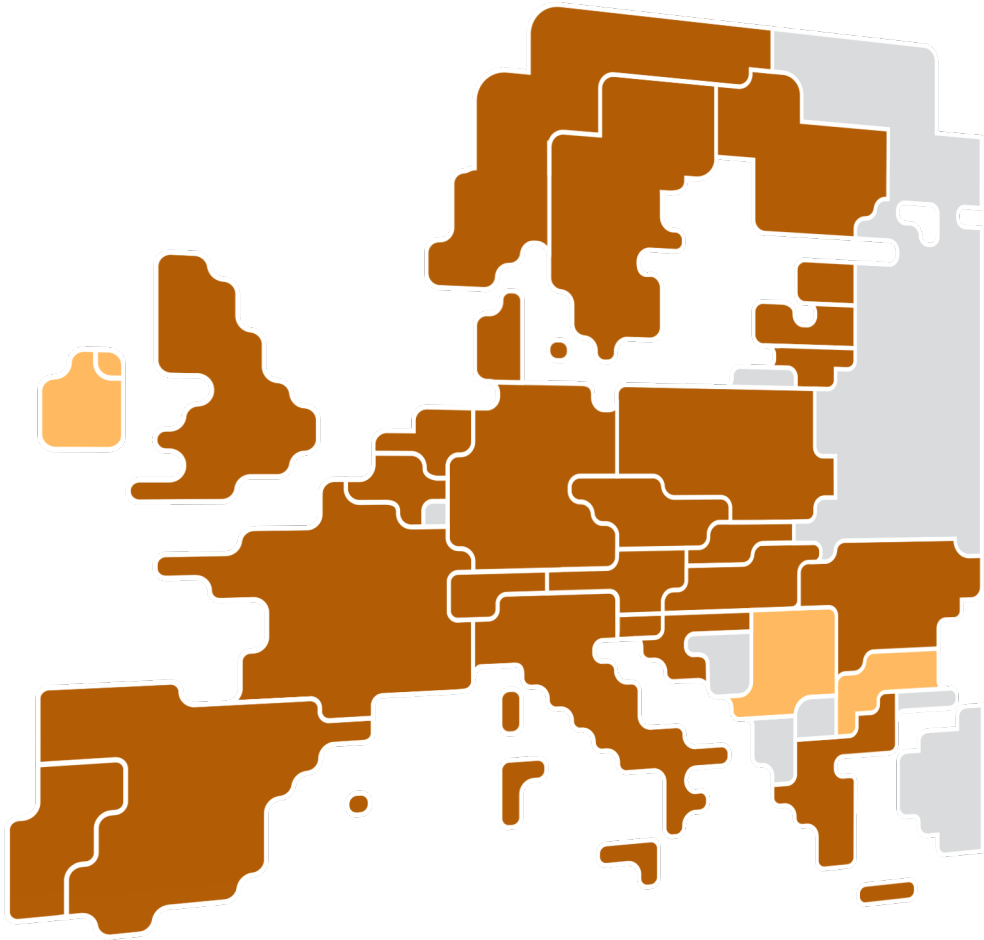


Settlement price for Direct Activated energy delivered in:	
QHi	**QHi+1**
MAXorMIN(CP_{SA} QHi; MP_{DA} QHi)	MAXorMIN(CP_{SA} QHi**+1**; MP_{DA} QHi)
	

- 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

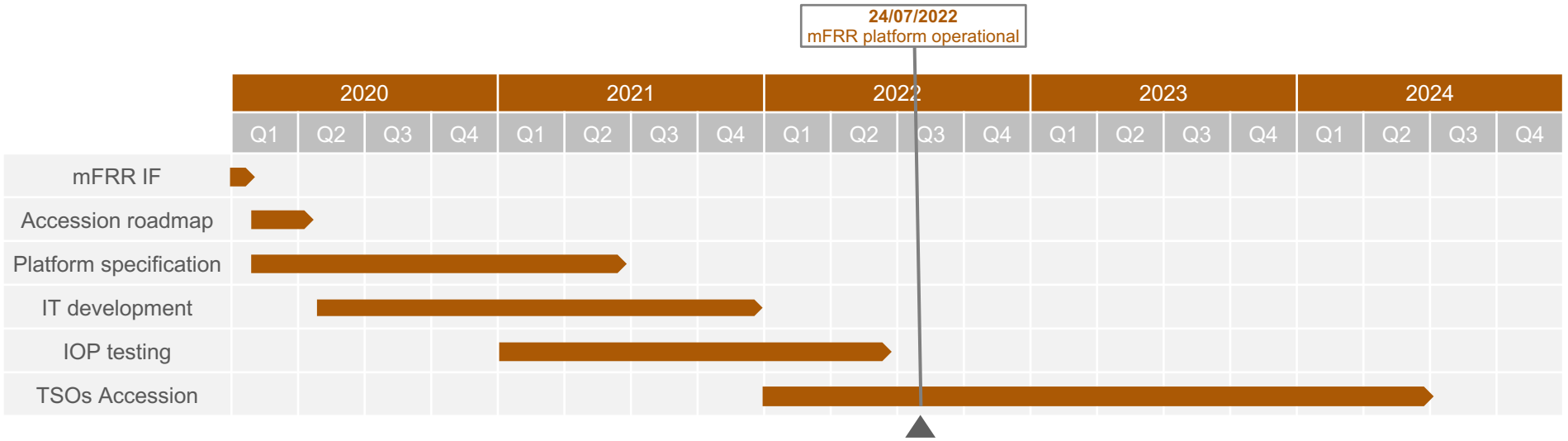
* In case of price indeterminacy

MARI Project timing



Project Timeline

TSOs establish project planning until 2024 to include all MARI partners

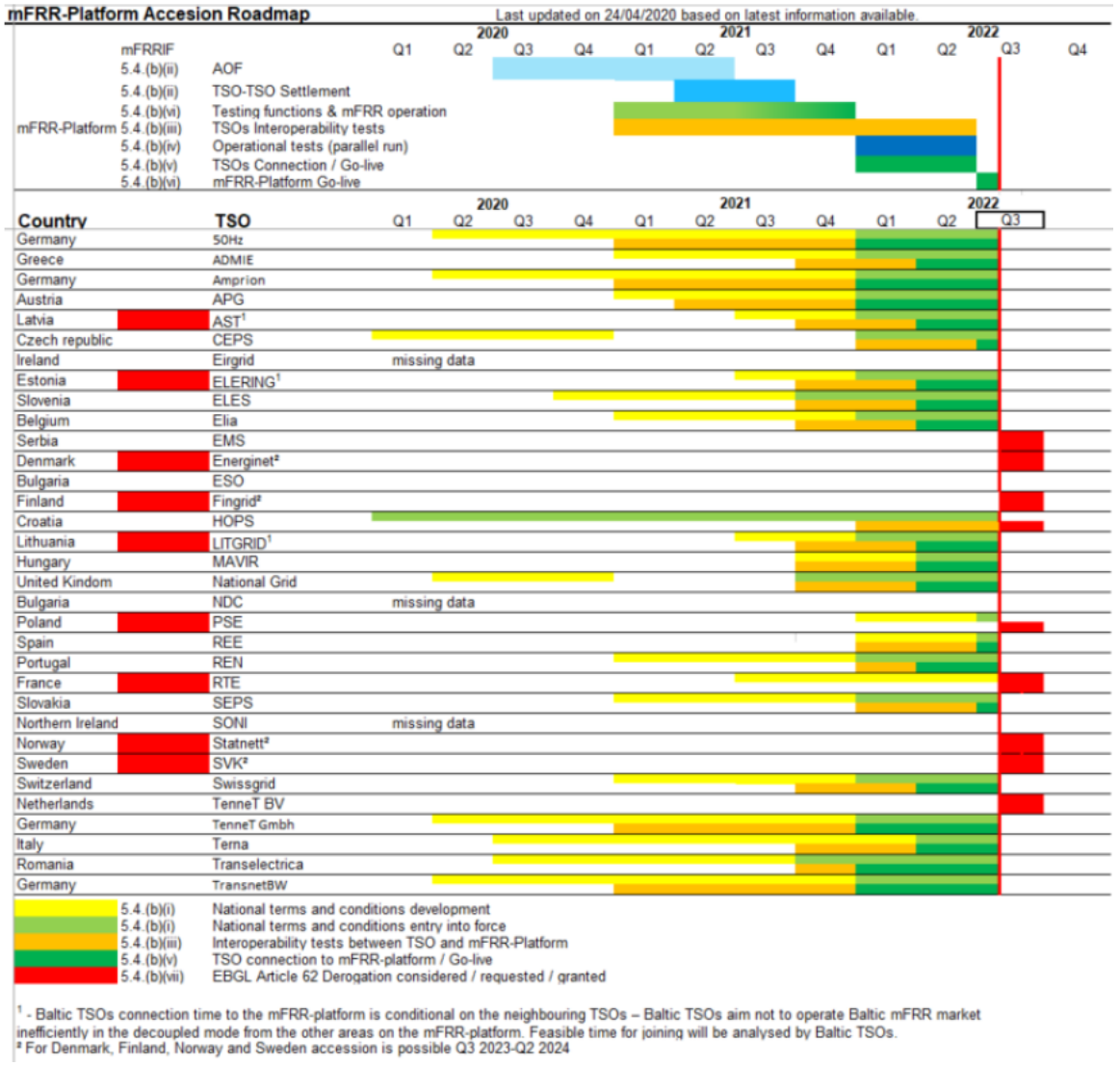


- The mFRR IF (Implementation Framework) is approved by ACER on 24th of January 2020
- TSO have published their planning for accession to the platform on 24th of April 2020

- 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