

Paid-as-cleared for R2 & R3 activated energy

STUDY under consultation (period of consultation 20/10/17 – 17/11/17)

Working Group Balancing 08/11/2017 10:00-12:00

Agenda

- ❑ Scope study
- ❑ Basic theory
- ❑ Context study
- ❑ EU benchmark
- ❑ Technical design
- ❑ CBA results
- ❑ Conclusions study
- ❑ Next steps

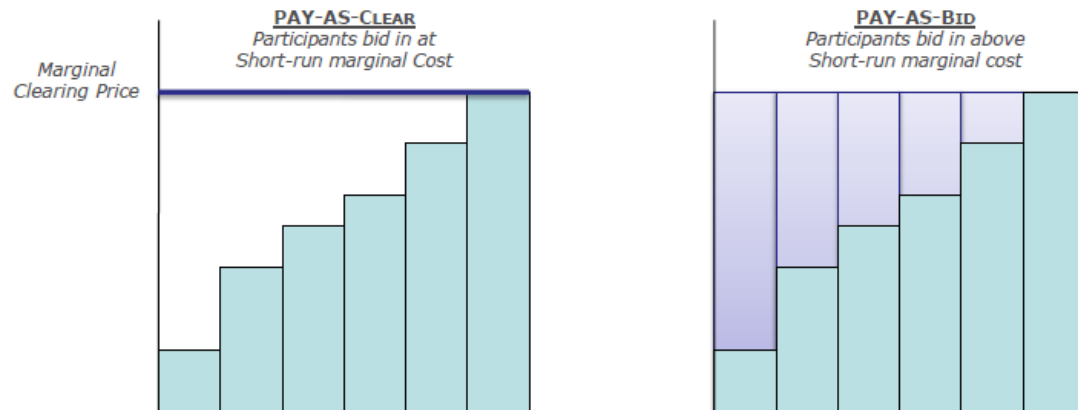
Scope study

Balancing processes	Current terminology	Description	Procurement	Energy settlement	Current existing Balancing Products
Imbalance netting process	IGCC	Technical netting of opposed imbalances between TSOs of different balancing areas	N/A	TSO-TSO	IGCC
Frequency Containment Process (FCR)	Primary reserves (R1)	Very fast reserves with as objective to stabilize the European frequency in case of deviations after an incident.	Contracted reserves	No	R1 200MHz, R1 100MHz Up, R1 100MHz Down, R1 100 MHz
Automatic Frequency Restoration Process (aFRR)	Secondary reserves (R2)	Fast reserves activated automatically and on a continuous basis to handle sudden disruptions in the area managed by Elia	Contracted & non-contracted reserves	Yes, Paid-as-bid	R2 reserves & bids (Up & down)
Manual Frequency Restoration Process (mFRR)	Tertiary reserves (R3)	Activated manually at request of Elia to address a major imbalance in the Belgian Control Area	Contracted & non-contracted reserves	Yes, Paid-as-bid	R3 Standard, R3 flex, CIPU Bids, Bids Bidladder

Paid-as-cleared for balancing energy only

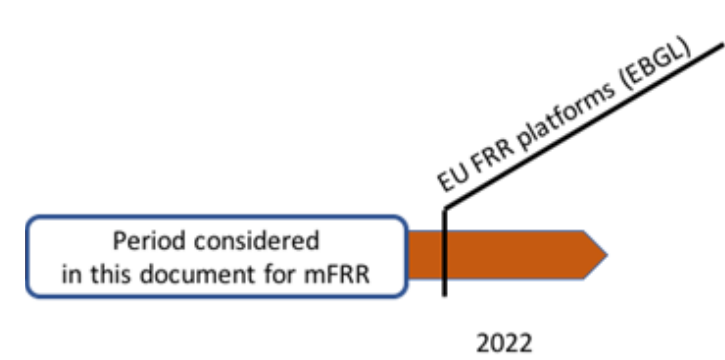
Basic theory paid-as-cleared

- ❑ Paid-as-cleared (also called marginal pricing) is a uniform pricing mechanism that offers the same price to all transactions of a given product at a certain point in time based on the marginally accepted order.
- ❑ Paid-as-bid is a pricing mechanism that enables a different price for each transaction, i.e. each transaction price is determined by the price set in the accepted bid



- ❑ From economic theory, paid-as-cleared and paid-as-bid provide the same results under perfect competition assumptions
- ❑ In practice though, perfect competition conditions never perfectly hold in any practical case.

Context : EU



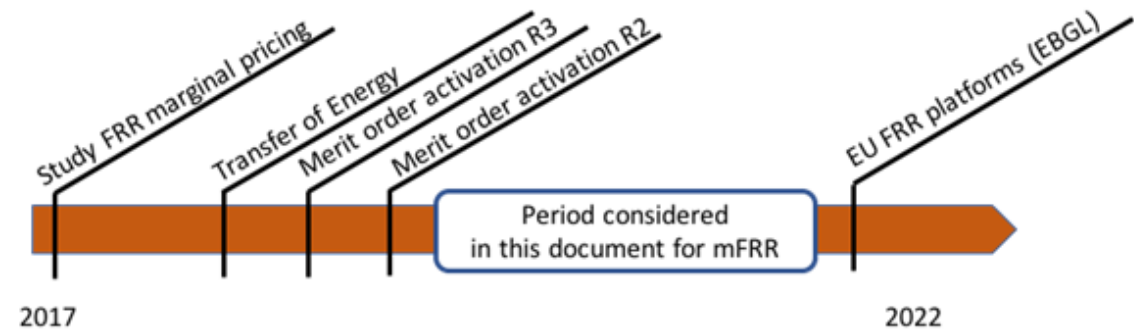
❑ European Balancing Guidelines (EBGL)

- ❑ describe the key principles organization of a regional market for aFRR/mFRR
- ❑ Require the use of harmonized pricing mechanism for the settlement of balancing energy for standard balancing products as soon as a TSO is joining the common European platform
- ❑ Require the pricing mechanism should be based on paid-as-cleared principles
- ❑ Impose TSOs to join the European FRR platforms before +/- the end of 2021

⇒ Balancing energy will be settled paid-as-cleared as of end of 2021 in EU solutions

⇒ Scope of this study: consider an earlier implementation of paid-as-cleared in Belgium

Context : Local pre-conditions



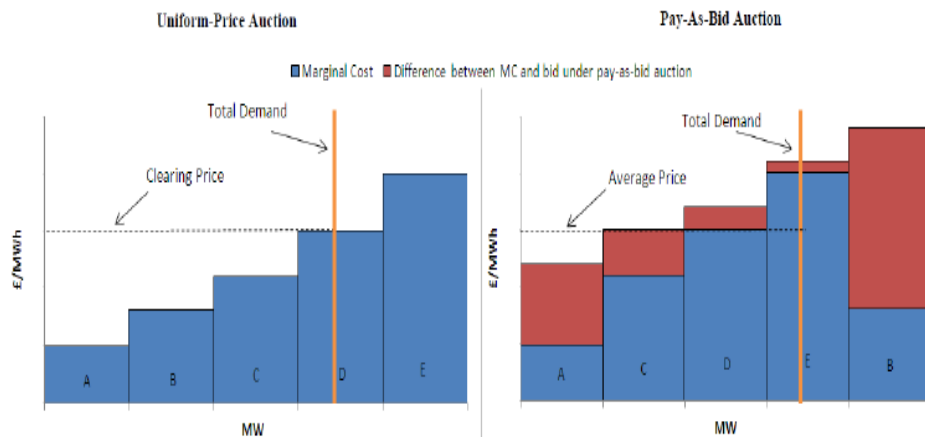
- ❑ Transfer of Energy (as each bid need to have an activation price)
 - ❑ aFRR: assessment technical implication ongoing in R2 non CIPU
 - ❑ mFRR: ToE applicable for all mFRR before end 2018
- ❑ Merit order activation of energy (bids need to be activated based on their price ranking)
 - ❑ aFRR: not possible before end 2019
 - ❑ mFRR: planned for end 2018

⇒ Merit order activation of balancing energy & Transfer of Energy are pre-requisites to implement paid-as-cleared settlement of activated energy

Theoretical advantages of PAC vs PAB

PAID AS CLEARED

- Efficient dispatch under imperfect information



- Incentive to set bidding price at (+/-) asset's marginal cost
- “Incentive for Bidding” (hence competition) is facilitated by homogeneous remunerations for homogeneous services

PAID AS BID

- Simplicity
- Incentive to bid at (+/-) system marginal cost (efficient if mark-ups do not necessary disappear under PAC?)
- convenient way to remunerate **heterogeneous products**
- Increase the price difference between activated energy and imbalance prices => incentive to deliver

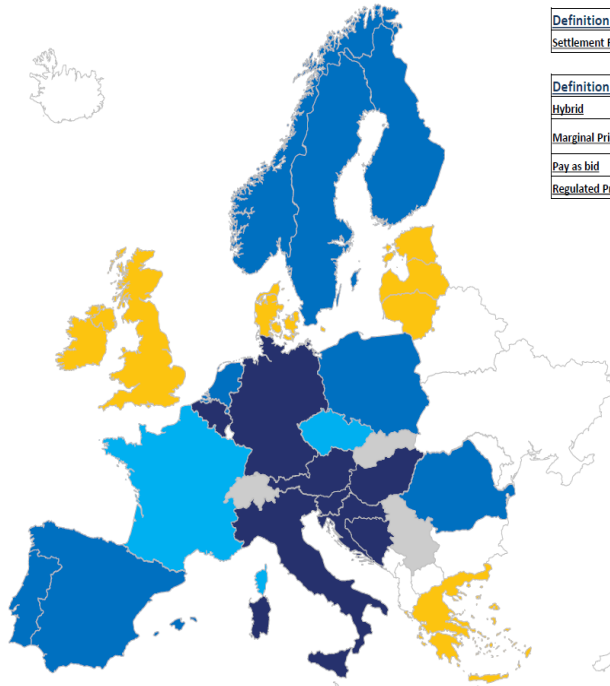
	Paid-as-bid Single Marginal Imbalance pricing	Paid-as-Cleared Single Marginal Imbalance pricing
Delivery	++	--
Over-Delivery	+	+
Bidding price	--	++
Incentive for bidding	+/-	++ ⁷

EU benchmark

aFRR

AS9.4

Frequency Restoration Reserve (Automatic) - Energy - Settlement Rule



Definition of question	
Settlement Rule	The pricing rules for settlement.
Definition of answer	
Hybrid	Combination.
Marginal Pricing	Marginal pricing is the change in total cost that arises when the quantity produced changes by one unit.
Pay as bid	Contracted parties who provide a service are paid based on their offer price.
Regulated Price	Price for this service is based on a price that is set by the relevant regulatory authority.

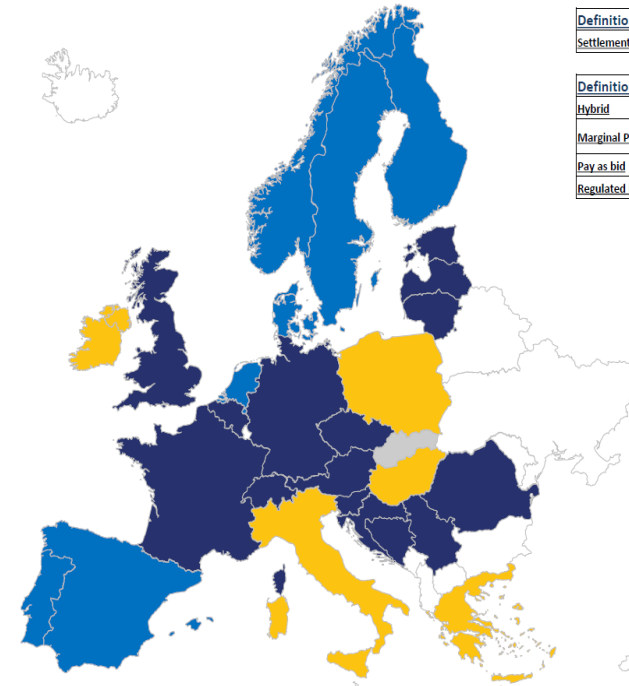
Key:

Missing data	
N/A	Yellow
Pay as bid	Dark Blue
Marginal Pricing	Light Blue
Regulated Price	Medium Blue
Hybrid	Grey

mFRR

AS9.6

Frequency Restoration Reserve (Manual) - Energy - Settlement Rule



Definition of question	
Settlement Rule	The pricing rules for settlement.
Definition of answer	
Hybrid	Combination.
Marginal Pricing	Marginal pricing is the change in total cost that arises when the quantity produced changes by one unit.
Pay as bid	Contracted parties who provide a service are paid based on their offer price.
Regulated Price	Price for this service is based on a price that is set by the relevant regulatory authority.

Key:

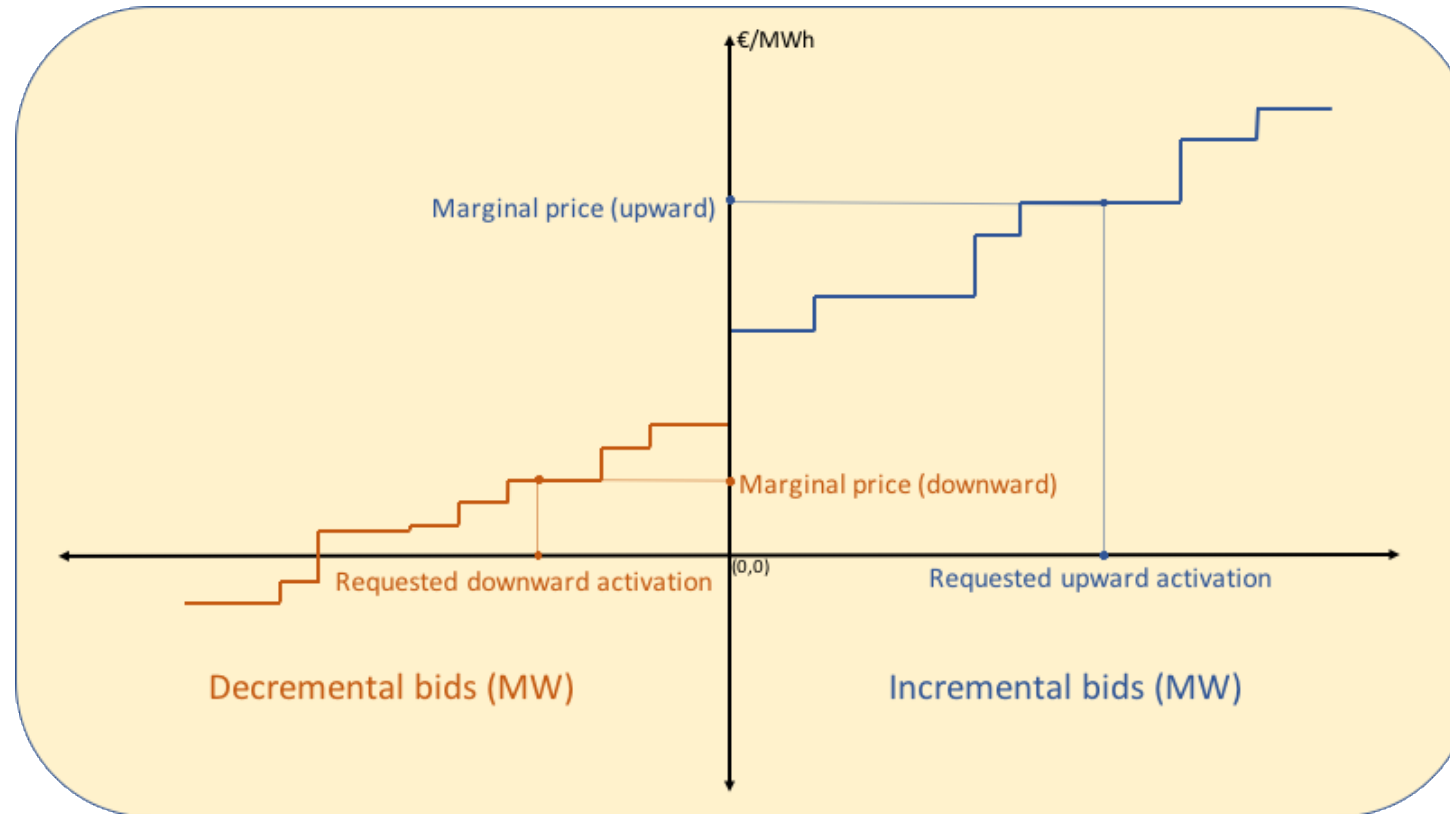
Missing data	
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Currently paid-as-cleared is not applied by many countries

Technical design mFRR: Content

- ❑ Basic model
- ❑ sophisticated products: indivisible bids (when implemented)
- ❑ Dummy energy
- ❑ Direct activated vs scheduled activated
- ❑ Inversal pricing
- ❑ use of bids for congestion & interTSO

Technical design mFRR: basic model



- The settlement price always equals to the price of the last activated bid, whether entirely or partially
- In case R3 flex is still at end of MO: the mFRR settlement price is set at the most extreme between the activation price with the “free bids and R3 standard merit order” on the one hand and “R3 Flex merit order” on the other hand

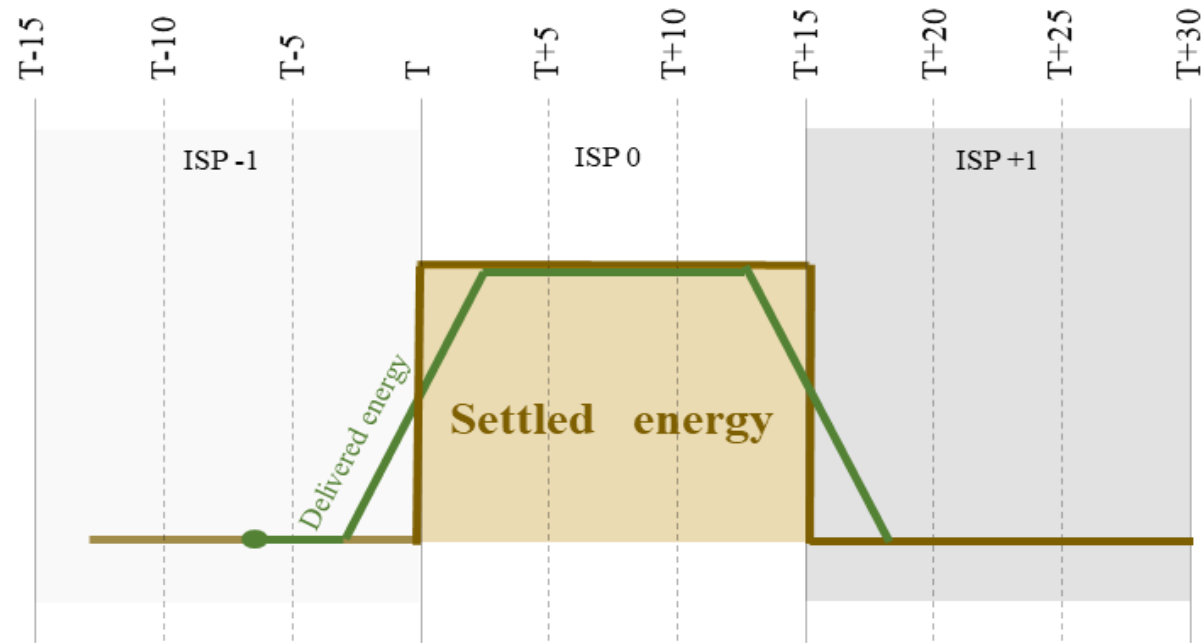
Technical design mFRR: sophisticated products

- Currently all mFRR & aFRR bids are divisible in Belgium
- The introduction of indivisible bids requires more complex price determination algorithms
- **The proposed heuristic (that would be used in presence of indivisible bids in mFRR) sequentially accepts the bids in merit order, except that if the acceptance of an indivisible bids provides a larger volume than the activation request (subject to tolerances as the case may be), in which case this bid is ignored (i.e. rejected paradoxically) and the next bid is considered.**

Bid	Price	Volume	Indivisible	Solution 1	Solution 2	Solution 3	Solution 4
A	30 €/MWh	15 MWh	yes	15 MWh		15 MWh	
B	40 €/MWh	20 MWh	no	10 MWh	20 MWh	20 MWh	20 MWh
C	50 €/MWh	50 MWh	yes	50 MWh	50 MWh		
D	60 €/MWh	60 MWh	no	0 MWh	5 MWh	40 MWh	55 MWh
Negative welfare term				€ -3.350	€ -3.600	€ -3.650	€ -4.100
Price of last activated bid				50€/MWh	60€/MWh	60€/MWh	60€/MWh

In this example, solution 3 would be selected

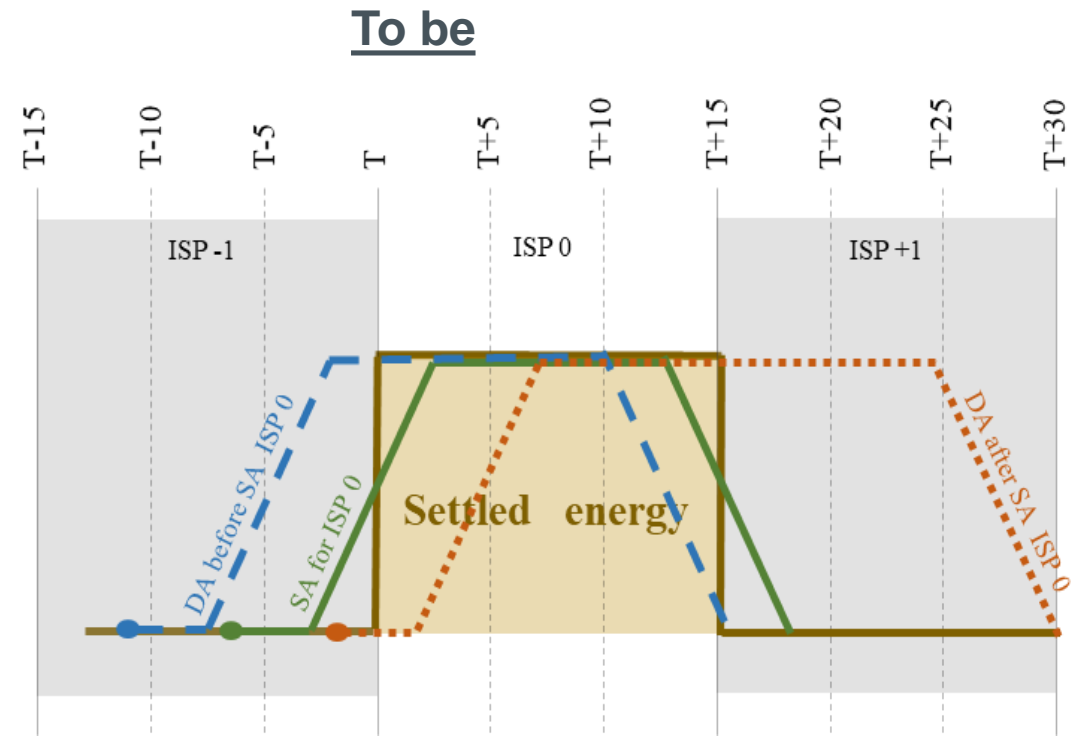
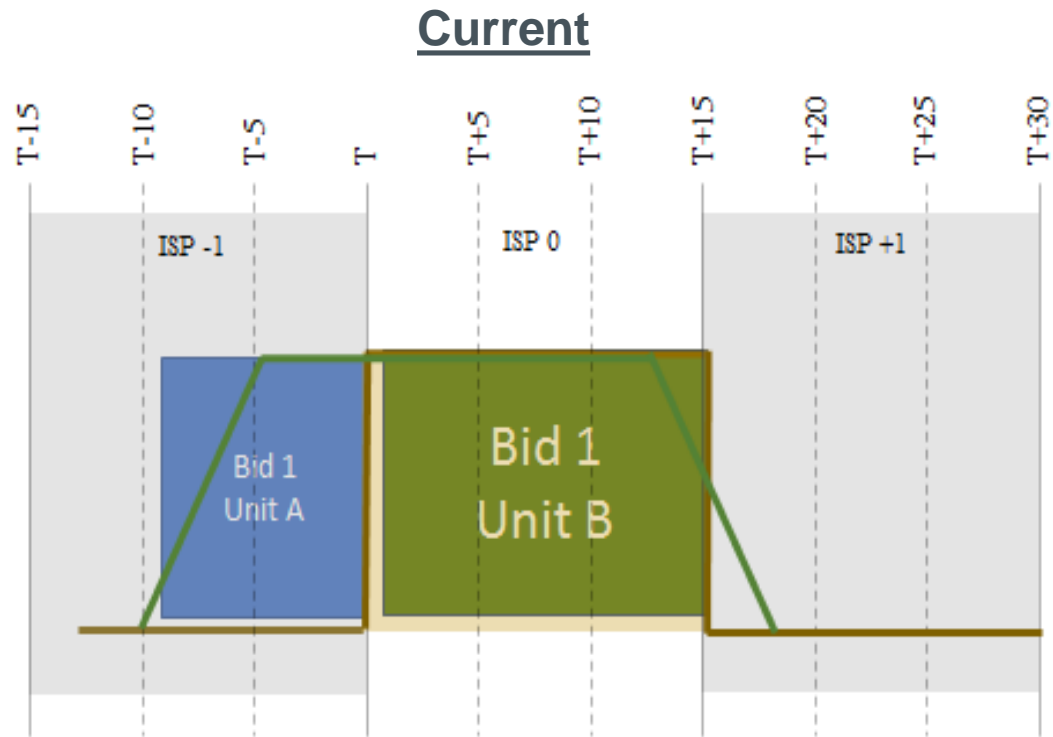
Technical design mFRR: dummy energy



➤ General principle:

- Only the requested energy is accounted for and settled at the marginal price during the corresponding ISP
- Dummy energy is not valorized specifically, i.e. the standard block approach prevails

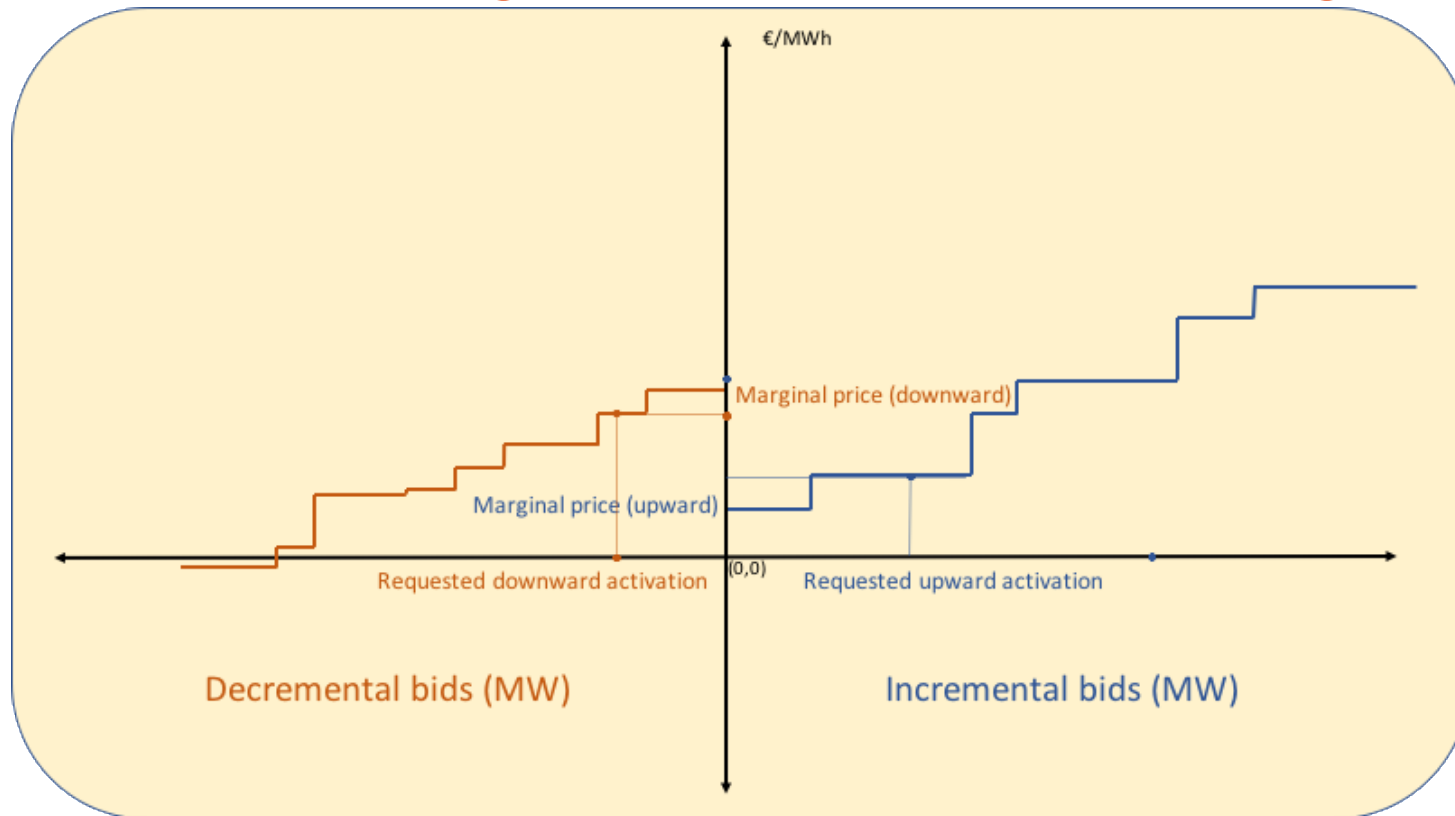
Technical design mFRR: Direct activations



In case of direct activations, bids could be activated for a limited durations and energy (currently not problematic in practice due to absence of substantial changes of merit order from one hour to the next one)

Currently being addressed at European level: if minimum duration of activation of 15 min required, It then remains an open question how to settle the energy activated outside the main ISP of the bid.

Technical design mFRR: Inversal pricing

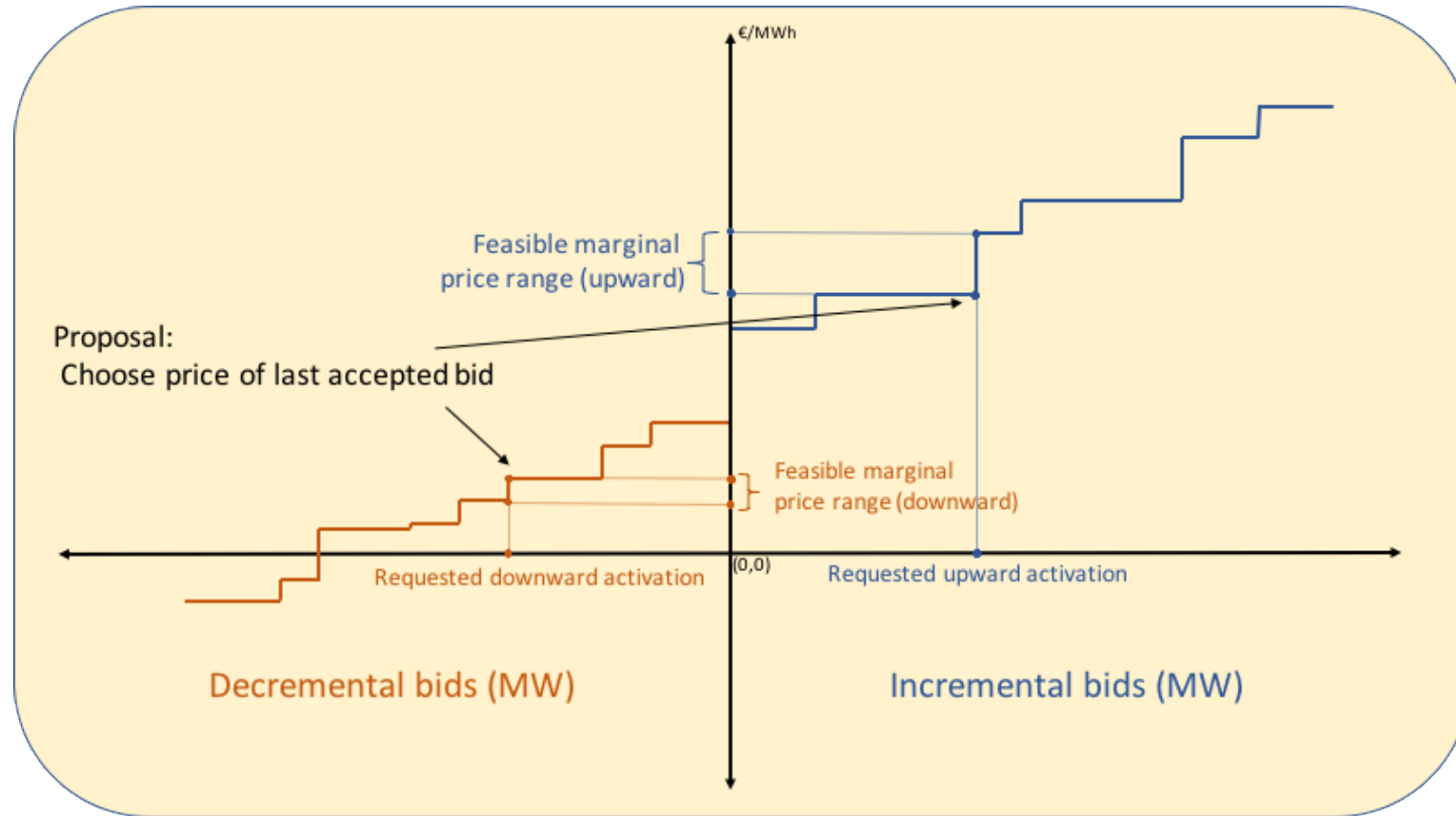


Potential solution:

- Activation of D bid 100 MWh at 60 €/MWh: Elia receives 6000 €
- Activation of I bid 100 MWh at 50 €/MWh: Elia pays 5000€
- Net result for Elia: + 1000€ & potential gains for BSPs (as 2 bids activated)

- Inversal prices marginal price for upward regulation below marginal price for downward regulation
- Inversal prices can occur if the cheapest incremental bid is cheaper than the most expensive decremental bid
- **Proposal is accept the occurrence of inversal prices**

Technical design mFRR: price indetermination



- In case of price indeterminacies, proposal is settle at the price of the last accepted bid

Technical design mFRR: use of bids for congestion

- Current situation: CIPU bids can be used for both balancing and local congestion purposes
- Future situation: EBGL clearly states that “*at least balancing energy bids activated for internal congestion management shall not set the marginal price of balancing energy*”. Reasoning is that not always the cheapest bid may appear as the most efficient (or possibly even the only) solution to e.g. alleviate a local congestion.
- Future (Proposal iCAROS): separate bids for congestion (cost based) by scheduling agent & balancing (free price) by BSP
- Note also that congestion management actions are typically done more ahead of real-time than the envisaged timing applicable to usage of bids for balancing

Proposal:

1. Activate bids for congestion management based on a paid-as-bid or regulated principle
2. Activate balancing energy based on a paid-as-cleared principle (shortly before real-time)

Technical design aFRR: two possible basic models

M1: Unique aFRR settlement price per ISP based on largest activations (with possibly a minimum activation time)

- aFRR settlement price for a given ISP equals the price in the merit order of the largest aFRR set point that has been activated during at least X seconds (e.g. 30 seconds).
- Bids activated less than X seconds are remunerated paid-as-bid
- Key advantage: simpler technical implementation (FSP/TSO store data on a less granular level)

M2: Different aFRR settlement prices every X seconds

- A different marginal settlement price is calculated for every sub-period of X seconds (e.g. 4 seconds)
- Bids are remunerated based on the sub-period marginal prices
- Key advantage: cross-border integration: congestion ⇔ equal prices whereas it may be that a given network constraint is binding only during a sub-period of the ISP

No clear conclusion yet: the M1 vs M2 choice remains somewhat open for the moment.

Topic under discussion at European level in the PICASSO project (Balancing Energy Pricing Period)

Final choice might affect implementation timeline

Linking prices between products?

- Cross-product pricing FRR vs. IGCC => **considered irrelevant**
- Cross-product pricing aFRR vs. mFRR => **little added value**
 - Heterogeneity of products suggests that different settlement prices should apply,
 - Disturbs coherence between clearing prices and acceptance/rejection of bids (i.e. out of money bids not necessarily rejected),
 - Disturbs coherence between clearing prices and XZ congestion pricing (i.e. the “no congestion equal prices” rule)
 - Practical concern: transnational FRR pilot initiatives have different scopes for aFRR and mFRR (hence different projects and IT infra.)
- Cross-product pricing mFRR vs. TSO-TSO support => **makes sense**
 - In case ELIA supports neighboring TSOs:
 - the supporting energy is included in the marginal price formation for balancing energy
 - the supporting energy is not included in the imbalance price formation
 - In case ELIA requires support from neighboring TSOs:
 - the cost of this support (as specified by the reserve sharing arrangements) serves as a bound for the mFRR remuneration

CBA: assumptions

■ Set of bids

- Dataset used for the simulations are available aFRR and mFRR bids for entire year 2016
- No additional bids have been populated for the purpose of the simulations / overall liquidity has not been artificially improved
- All aFRR & mFRR bid prices are unchanged (although bid prices under pay-as-cleared should replicate only the marginal costs)
- Startup costs remain excluded from the mFRR bid prices

■ Activated volumes

- The requested aFRR and mFRR volumes remain unchanged
- Activation requests granularity is per minute for aFRR activations and per 15 minutes for mFRR activations

=> So far, we have “historical pro-rata/prioritized activation” dataset

- aFRR and mFRR bids are activated based on full merit order

=> We obtain “simulated merit order activation PAB” datasets

■ Pricing

- The activation and price calculation procedures as described in the consultation where implemented
- For aFRR M1 model (respectively M2), the minimal duration (resp. the duration of ISP sub-periods) is set to 1 minute

=> This gives “simulated merit order activation PAC” datasets

CBA results: aFRR

Summary of aFRR simulations

aFRR (total costs)	Inc	Dec	Inc + Dec
Historical pro-rata activation	12.878.938 €	-3.304.405 €	9.574.533 €
Simulated merit order activation PAB	11.734.581 €	-4.006.891 €	7.727.690 €
Simulated merit order activation PAC M1	16.274.010 €	-1.658.164 €	14.615.847 €
Simulated merit order activation PAC M2	14.657.933 €	-2.486.853 €	12.171.080 €

aFRR (variations)	Inc	Dec	Inc + Dec
From historical pro-rata activation to merit order PAB	-1.144.357 €	-702.486 €	-1.846.843 €
From merit order PAB to merit order PAC M1	4.539.429 €	2.348.727 €	6.888.157 €
From merit order PAB to merit order PAC M2	2.923.352 €	1.520.038 €	4.443.390 €
From historical pro-rata activation to merit order PAC M1	3.395.072 €	1.646.241 €	5.041.314 €
From historical pro-rata activation to merit order PAC M2	1.778.995 €	817.552 €	2.596.547 €

Conclusions:

- not a liquid and competitive market: limited number of bidders, and limited amount of price steps in the bid curves.
- BSPs will be remunerated 4 M€- 6M€ higher compared to merit order PAB. Amount currently used to reduce the costs covered by access tariffs. NB: shift from pro-rata activation to merit order PAB = gain of < 2 M€
- Unlikely/unclear whether this increase will be compensated by lower capacity costs due to better liquidity in the market (requires decrease in sourcing costs of reserves 3-5 €/MW/h)

CBA results: mFRR

Summary of mFRR simulations

mFRR (total costs)	Inc	Dec	Inc + Dec
Historical prioritized activation	8.922.073 €	-167.174 €	8.754.898 €
Simulated merit order activation PAB	4.503.878 €	-357.884 € ¹	4.145.993 €
Simulated merit order activation PAC	5.167.830 €	36.133 €	5.203.963 €

mFRR (variations)	Inc	Dec	Inc + Dec
From historical prioritized activation to merit order PAB	-4.418.195 €	-190.710 €	-4.608.905 €
From merit order PAB to merit order PAC	663.952 €	394.018 €	1.057.970 €
From historical prioritized activation to merit order PAC	-3.754.243 €	203.308 €	-3.550.935 €

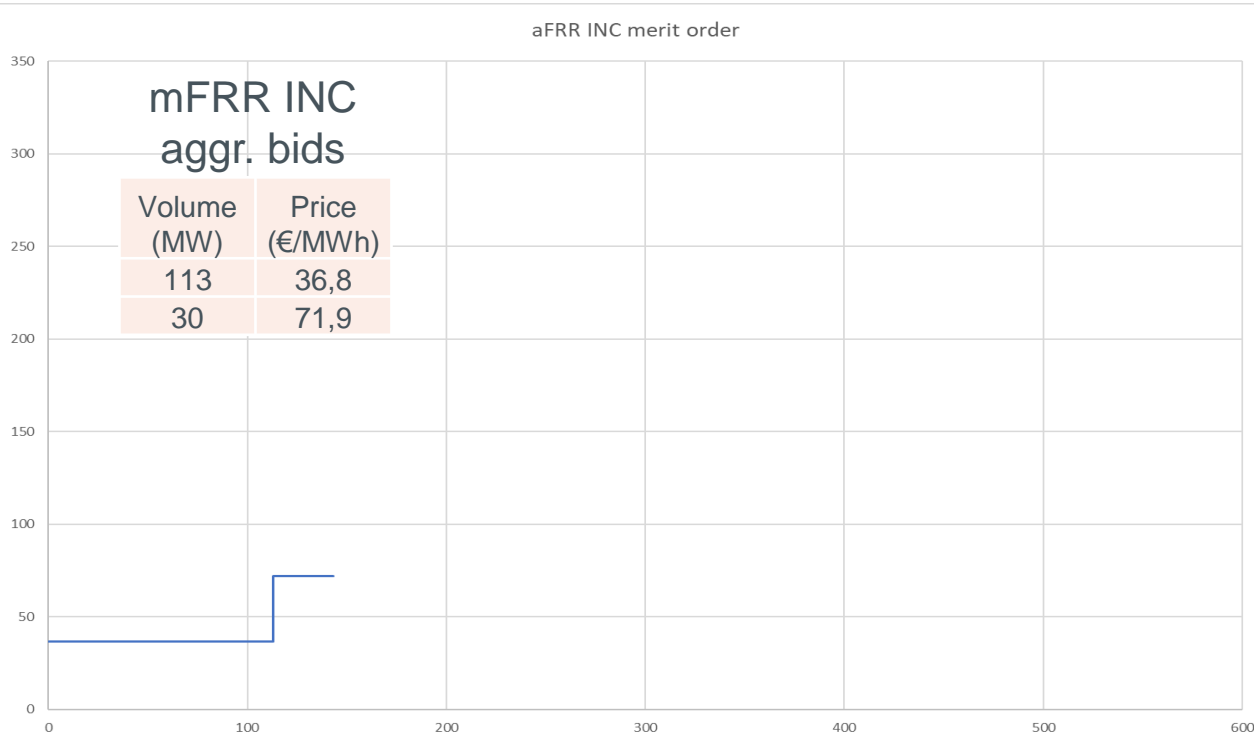
Conclusions:

- In evolution to a liquid and competitive market: different kind of bidders, and sufficient amount of price steps in the bid curves.
- BSPs will be remunerated 1M€ higher compared to merit order PAB. Amount currently used to reduce the costs covered by access tariffs. NB: shift from prioritized activation to merit order PAB = gain of > 4,5 M€
- Likely that this increase could be compensated by lower capacity costs due to better liquidity in the market (requires decrease in sourcing costs of reserves 0,15 €/MW/h)

Liquidity difference aFRR vs. mFRR

Typical aFRR merit order:

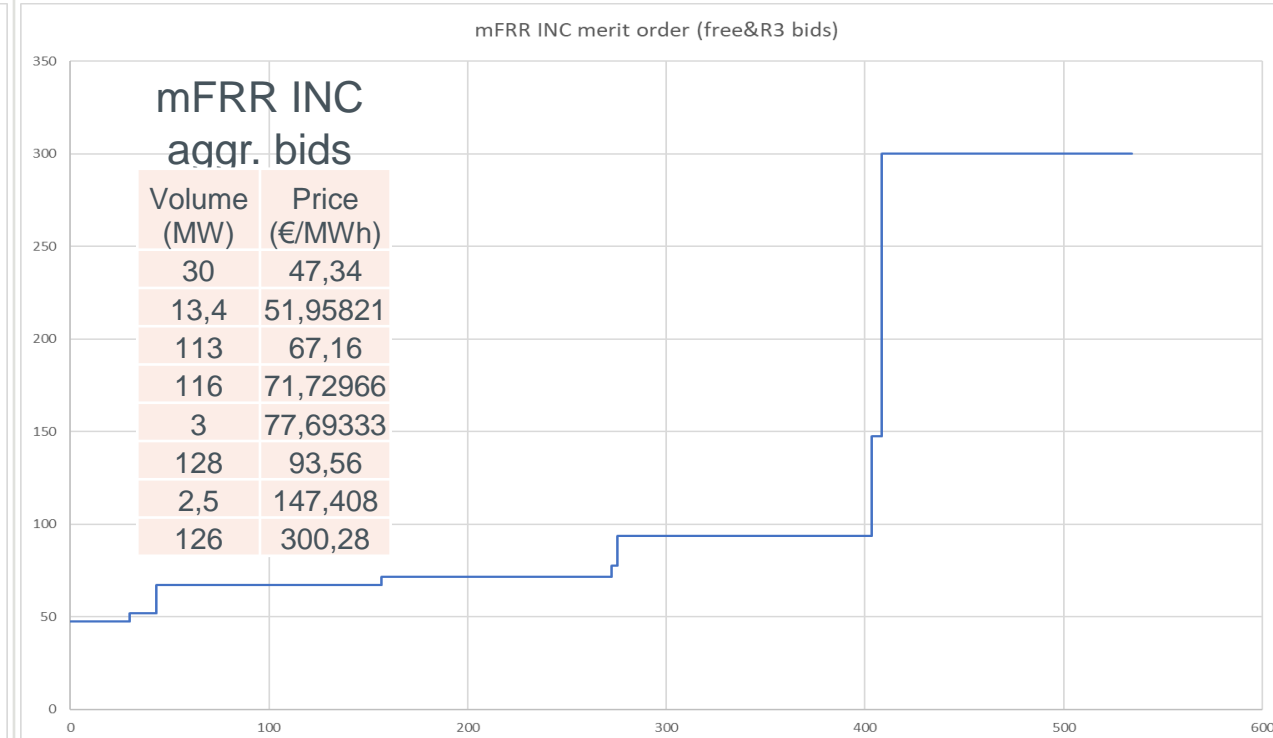
- 2 bids / 2 prices stemming from 2 market parties
- Prices are often corrected to fit into caps & floors



Absence of liquidity + caps & floor = PAC inefficient

Typical mFRR merit order:

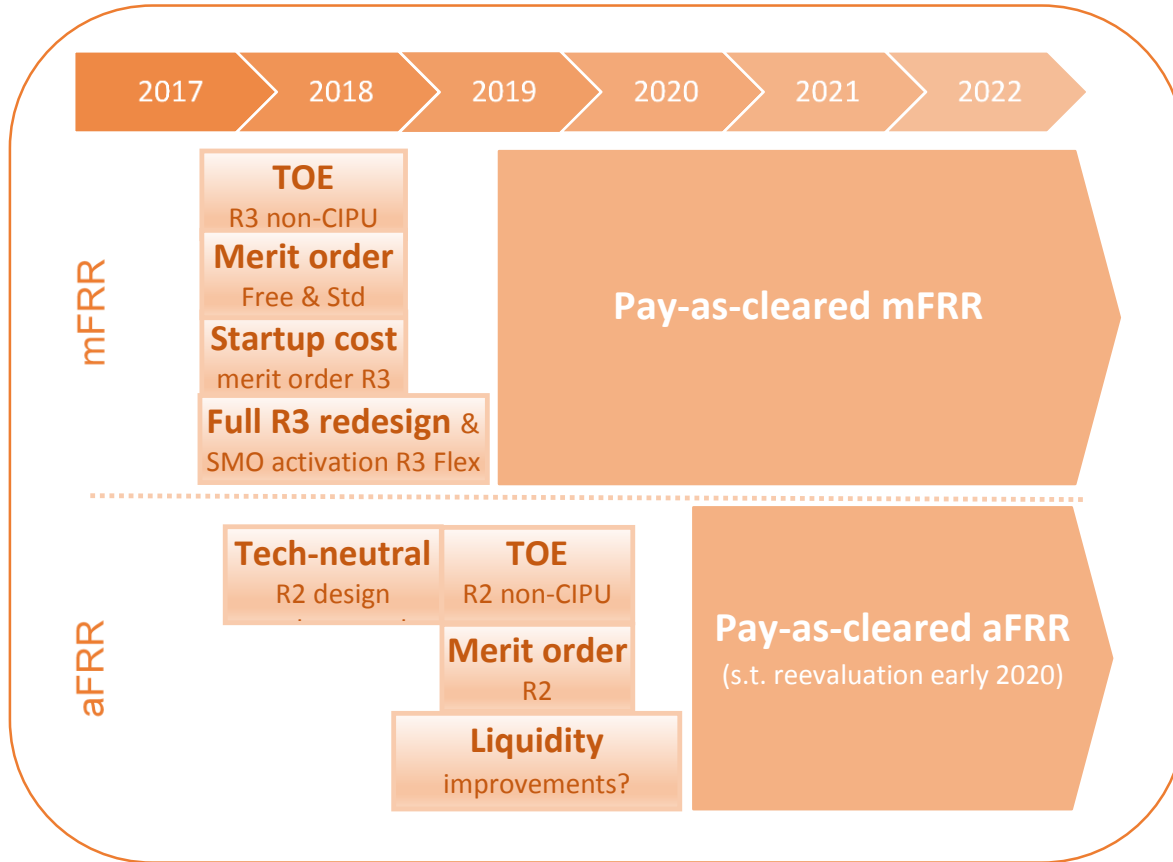
- > 10 bids, > 6 price steps, from > 3 market parties
- Free prices



« Fair » liquidity + free prices = PAC possible

Recommendations

Implementation of marginal pricing for FRR activated energy is in general desirable, but there are preconditions



Technical implementation of PaC mFRR

- precise price formation heuristic is presented for mFRR
- Pre-conditions:
 - Merit order activation Free & Std bids
 - Transfer of Energy R3 non-CIPU
 - Startup costs in merit order R3
- Give priority R3 redesign project (eg. daily procurement, standardisation)

Technical implementation of PaC aFRR

- 2 fundamentally different models M1 & M2 with different implementation timings – stakeholder impact
- Pre-conditions:
 - Transfer of Energy R2 non-CIPU
 - Merit order activation R2
 - ... level of liquidity after these improvements?

Next steps

- 8 /11: stakeholder workshop (today)
- **17/11: End of consultation**
- End of November: adaptations of the study based on consultation results
- Mid December: publication of final study on ELIA's website
- Implementation will be made according to the plan proposed in final version of the study

Many thanks for your attention!

ELIA SYSTEM OPERATOR
Boulevard de l'Empereur 20
1000 Brussels

+32 2 546 70 11
info@ elia.be

www.elia.be
An Elia Group company

Back Up Pro-Rata vs Merit order

