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Technical Assistance to the Implementation of Cross-border Electricity Balancing

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Workshop ENTSO-E & WB6
Vienna, 28.02.2019

Agenda

Session 1: Implementation of a regional balancing market	09:00 – 11:30
- European balancing platforms – status	ENTSO-E
- WB6 Roadmap towards Regional/European balancing market	EKC/IMP
- Discussion	WB6 XB PSC/ECS

Today:

- **WB6 XB Balancing Project: basic information**
- **Key deliverables**
- **Current state WB6 & gap analysis**
- **Imbalance Netting: model, analyses, benefits**
- **mFRR/RR exchange: model, analyses, benefits**
- **Implementation Roadmap**

XBB Balancing project: Key information

- **Under the initiative and support of Energy Community,**
- **With WB6 Contracting Parties as partners and final beneficiaries,**
- **EKC and IMP performed the project "Technical Assistance to the Implementation of Cross-border Electricity Balancing" in the WB6 region**

The main goal of the project:

In line with EU (EBGL) roadmap and in line with the state of art in the region, to prepare the WB6 systems for the implementation of Imbalance Netting and mFRR/RR energy exchange mechanisms

With the following key aspects:

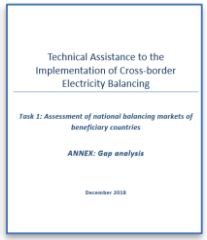
- **Current state and general gap analysis towards EB GL**
- **Theoretical and methodological aspects of Imbalance Netting and mFRR/RR**
- **Simulation software & dry runs & analyses**
- **Organisational and contractual needs**

START: Dec 2017, END: FEB 2019

Deliverables of the project

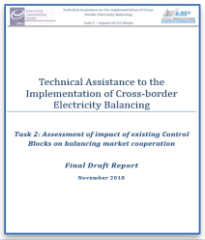
Task 1: Current state WB6

Final Draft Report &
detailed Gap analysis (Annex)



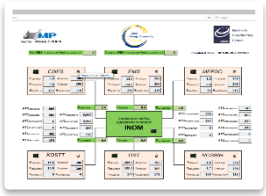
Task 2: Usage of LFC blocks

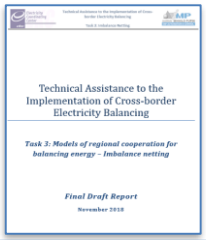
Final Draft Report &
detailed Gap analysis



Task 3: Imbalance Netting

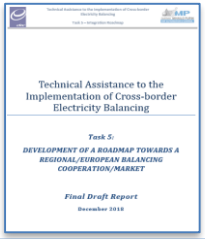
Target model,
IN software platform
IN tests&analyses
Final Draft Report





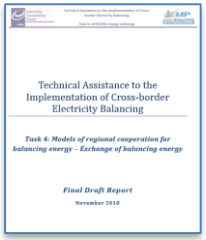
Task 4: mFRR/RR

Target model,
mFRR/RR software platform
mFRR/RR tests&analyses
Final Draft Report



Task 5: Integration roadmap

Integration steps,
Contractual framework,
Final Draft Report



Gap analysis towards EB GL, SO GL and regarding cooperation for balancing energy

- **Task 1: Summary gap analysis per EnC Parties**
- **Task 2: LFC blocks**

Gap Analysis of WB6 legislations

- ✓ WB6 primary and secondary legislative VS EBGL
- ✓ Legal and technical analysis
- ✓ Around 30 documents analyzed
- ✓ Comprehensive guideline on more than 350 pages

KEY EBGL REQUIREMENTS

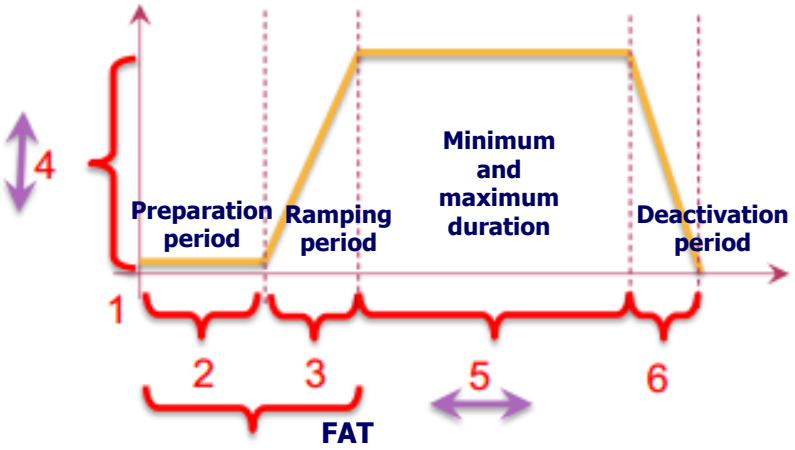
General provisions

- Numerous definition (such as balancing services, energy and capacity, BSP…)

Functions and responsibilities

- TSO shall be responsible for procurement of balancing services from BSP and shall apply Self-dispatching model
- BSP shall qualify for providing bids
- Contract for balancing capacity means obligation for bidding balancing energy
- Price of balancing energy can't be predetermined in contract for balancing capacity
- BRPs are financially responsible for their imbalances and they can reschedule their position before ICZGCT
- Balancing energy Gate Closure Time shall be close as possible to real time and not before ICZGCT
- Requirements for standard product
  - preparation period;
  - ramping period;
  - full activation time;
  - minimum and maximum quantity;
  - deactivation period;
  - minimum and maximum duration of delivery period;
  - validity period;
  - mode of activation

  And also variable characteristics:
  - price of the bid;
  - divisibility;
  - location;
  - minimum duration between the end of deactivation period and the following activation



- TSO may develop a proposal for specific products for balancing energy and balancing capacity

KEY EBGL REQUIREMENTS

Procurement of balancing services

- The activation of balancing energy bids shall be based on a TSO-TSO model with a common merit order list.
- All TSOs shall develop a proposal for a methodology to determine prices for the balancing energy
- Marginal pricing (pay as cleared)
- Harmonised maximum and minimum balancing energy prices are allowed, including bidding and clearing prices
- Upward and downward balancing energy bids shall be separated in different common merit order lists

- Procurement method for balancing capacity shall be market-based for at least the frequency restoration reserves and the replacement reserves
- the procurement process shall be performed on a short-term basis to the extent possible and where economically efficient

Cross-zonal capacity for balancing services

- Before the implementation of the capacity calculation methodology, TSOs shall use the cross-zonal capacity remaining after the intraday cross-zonal gate closure time

KEY EBGL REQUIREMENTS

Settlement

- The settlement processes shall ensure financial neutrality of TSOs
- TSO shall establish a procedure for the calculation of the activated volume of balancing energy based on requested or metered activation
- Payment for balancing energy :

	Balancing energy price positive	Balancing energy price negative
Positive balancing energy	Payment from TSO to BSP	Payment from BSP to TSO
Negative balancing energy	Payment from BSP to TSO	Payment from TSO to BSP

- Common settlement rules for: FRR, RR and imbalance netting
- Single imbalance pricing
- Imbalance settlement period of 15 minutes
- Each TSO shall set up the rules for: calculation of the final position, determination of the allocated volume, determination of the imbalance adjustment pursuant, calculation of the imbalance
- Payment for imbalance:

	Imbalance price positive	Imbalance price negative
Positive imbalance	Payment from TSO to BRP	Payment from BRP to TSO
Negative imbalance	Payment from BRP to TSO	Payment from TSO to BRP

- The imbalance price for negative/positive imbalance shall not be less/greater than the weighted average price for positive/negative activated balancing energy from frequency restoration reserves and replacement reserves.

KEY (NON)COMPLIANCES IN WB6 REGION

Functions and responsibilities

Compliant

- Self-dispatching model
- Role of BRPs

Non-compliant

- Prequalification process mostly missing
- Requirements for standard product are missing
- Possibility for NRA to regulate price of balancing capacity and energy in some cases

Procurement of balancing services

Compliant

- A general possibility for the TSO to exchange balancing services

Non-compliant

- “Pay as bid” pricing of balancing energy
- Limited price difference for balancing energy bids
- Annual procurement of balancing capacity with regulated prices
- Provision regarding exchange and transfer of balancing capacity are missing

KEY (NON)COMPLIANCES IN WB6 REGION

General provisions

Non-compliant

- Numerous definitions need to be reformulate and general inconsistency between legislations

Cross-zonal capacity for balancing services

Non-compliant

- Provisions regarding calculation and allocation of CZC for balancing services are missing

Settlement

Compliant

- Single imbalance pricing
- Procedure for calculation of activated balancing energy

Non-compliant

- Clear usage of imbalance adjustment is missing
- Imbalance settlement period is one hour
- Usage of coefficient determined by NRA for imbalance pricing
- Value of avoided activation of energy is not well defined
- Common pricing, settlement rules, CMOL and standard product between CGES , NOSBiH and EMS

KEY TAKE AWAYS FROM WB6 REGION

Key Takeaways

- Requirements for standard product are missing
- Exclude possibility for NRA to regulate prices
- Contracted/“pay as bid” prices should be changed to marginal pricing
- Imbalance settlement period is one hour
- Prices for balancing capacity are regulated and procurement is year ahead process
- Common pricing, settlement rules, CMOL and standard product between EMS,CGES and NOSBiH
- General inconsistency between documents and numerous definitions

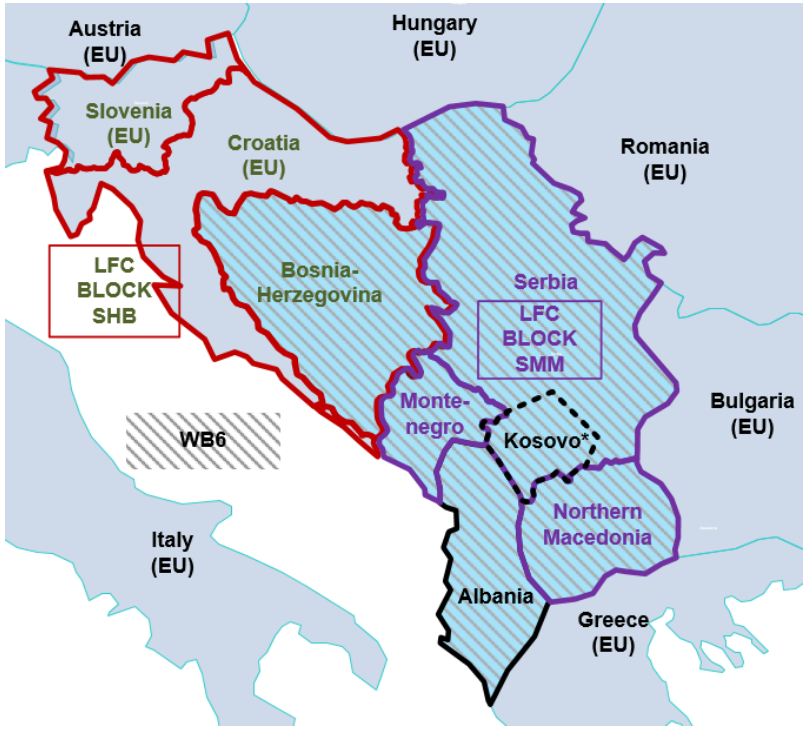
Task 2: Impact of LFC Blocks on integration

How to use the existence of Control Blocks, to boost further regional integration, in line with EU target model for balancing

- Common reserve dimensioning, as opportunity for lowering reserve
  - with ensured available CZC
- Exchange and sharing of the balancing reserve within the block
  - SO GL defines no limits for reserve sharing within the LFC block
- "Pre-netting" on the level of LFC blocks, under IGCC umbrella
- Existing IT infrastructure suitable for Pre-netting

LFC Blocks: Current state

- **SMM Control Block**
  - **Common FRR dimensioning, exchange of tertiary energy (mFRR/RR) applied between EMS and CGES, pilot tests of Imbalance Netting**
- **SHB Control Block**
  - **Adoption of new operational agreement in accordance with SO GL, exchange of tertiary energy (mFRR/RR) applied, Slovenia and Croatia are within ~~INC~~ IGCC (Feb 19)**
- **OST and KOSTT cooperation**
  - **Service agreement for provision of secondary control (still not operational)**
  - **No intention to form LFC block**

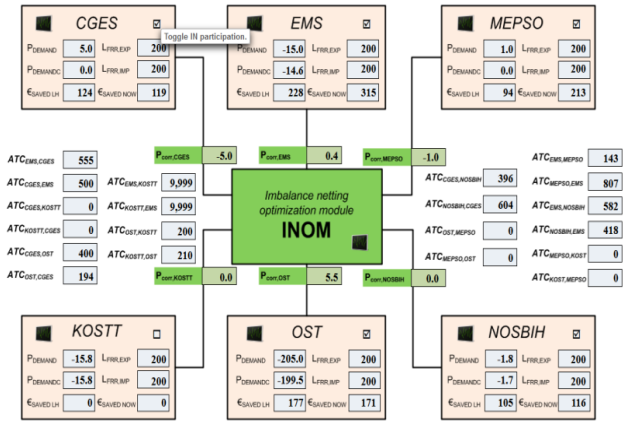


Imbalance Netting

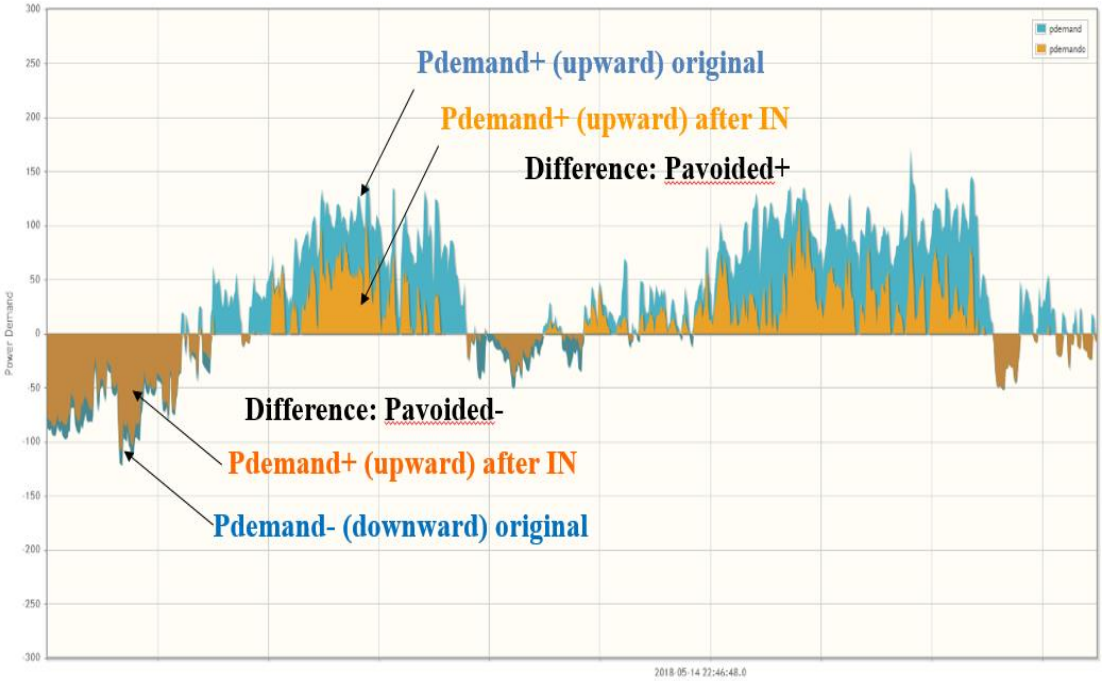
- Task 3 summary: model, analyses, benefits
- Task 5: IN Implementation roadmap

Imbalance Netting

- **Imbalance Netting target model for WB6: fully in line with pan-European model (IGCC project)**
  - **With assumed pre-netting at LFC block level**
- **IN demo platform delivered in April 2018**

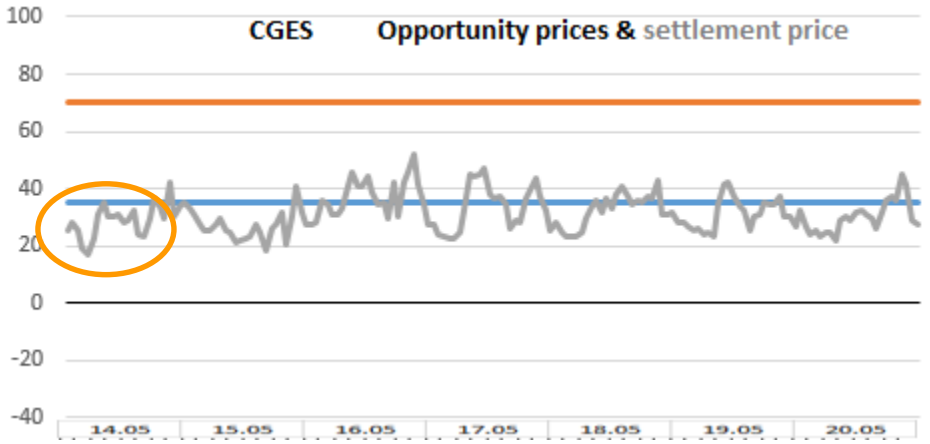


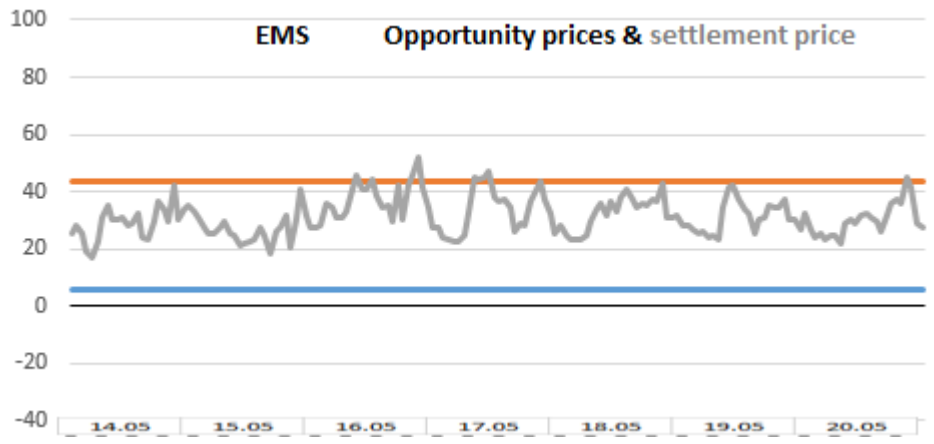
- **IN tests (experiment on WB6) performed on the TSOs' data for week 14-20 May 2018**

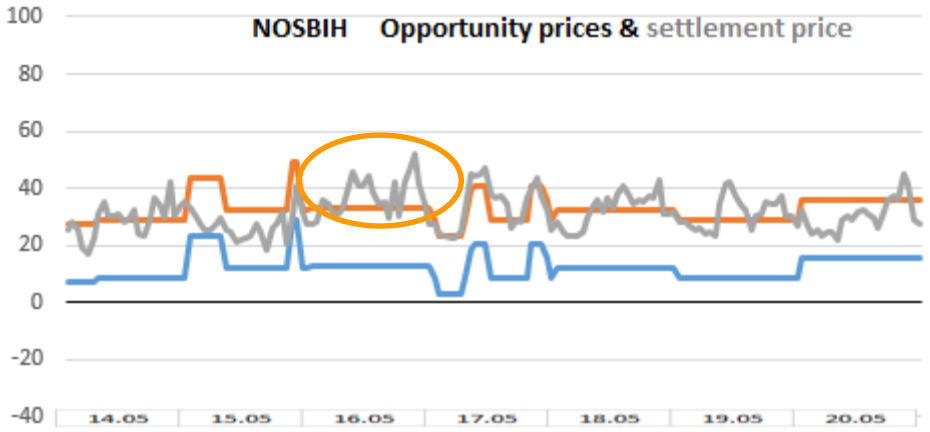


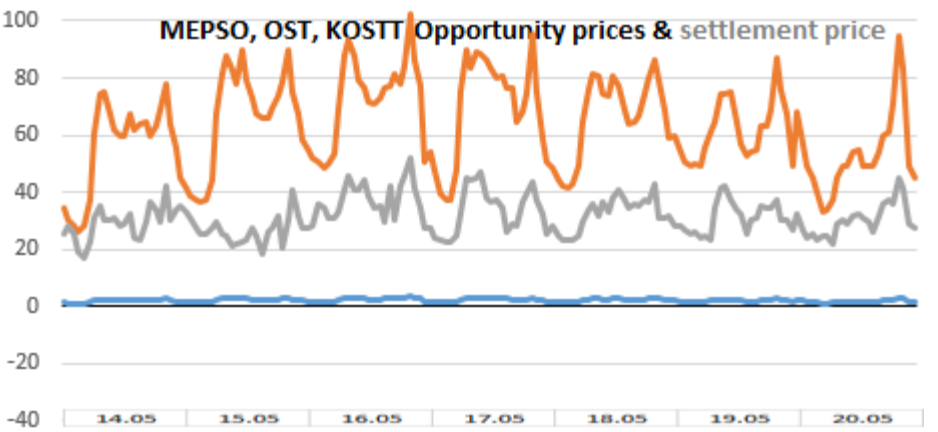
Opp. prices, settlement price

Opp. price, upward
Settlement price (WB6 test)
Opp. price, downward









Settlement price, as the result from "WB6 test" is shown as well

Perfect condition for max. savings is: Opp. Price, up > Settlement price > Opp. Price down

But, savings ensured for all TSOs even if it is not so in each timestamp

IN: Used data (Limits)

aFRR Limits: 200 MW per each TSO

ATC: Remaining ATCs after latest allocation (after day-ahead/Intraday) are used

Relatively high values: no congestions appear

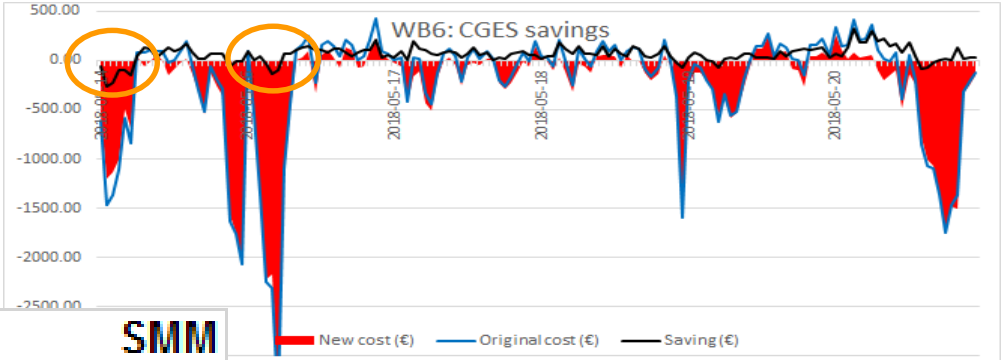
from_Bidding Zone	to_Bidding Zone	ATC average
CGES	EMS&KOSTT	431
CGES	NOSBIH	295
CGES	OST	400
EMS&KOSTT	CGES	554
EMS&KOSTT	MEPSO	187
EMS&KOSTT	NOSBIH	541
EMS&KOSTT	OST	210
MEPSO	EMS&KOSTT	763
NOSBIH	CGES	705
NOSBIH	EMS&KOSTT	459
OST	CGES	103
OST	EMS&KOSTT	100

IN tests: estimated savings, summary

Test 1: "WB6"

Test 2: "WB5" (without NOS BIH)

Test 3: "SMM" (EMS, CGES, MEPSO)



Savings, EUR	WB6	WB5	SMM
EMS	83,219	77,808	47,679
CGES	9,030	9,368	10,090
MEPSO	63,323	59,532	50,904
KOSTT	54,630	49,549	
NOSBIH	19,437		
OST	34,425	31,732	
Sum, 6 days	**264,064**	**227,989**	**108,673**
EMS, ≈year	5,062,489	4,733,320	2,900,473
CGES, ≈year	549,325	569,887	613,808
MEPSO, ≈year	3,852,149	3,621,530	3,096,660
KOSTT, ≈year	3,323,325	3,014,231	
NOSBIH, ≈year	1,182,418		
OST, ≈year	2,094,188	1,930,363	
Estimation, year	16,063,893	13,869,331	6,610,941

IGCC: implementation status in Europe

IGCC as the target IN project (as defined in INIF)

Member TSOs (20):

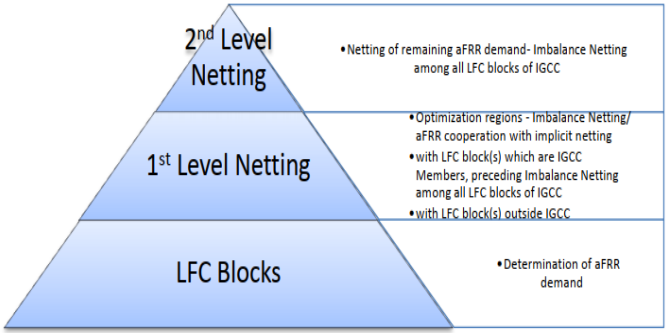
- **Operational members (13)**
- **Non-operational members (7)**
  - **EMS:** plan to operate within IGCC IN mechanism in Q2 2019
- **Observers (7): NOS BIH, CGES, MEPSO,** ESO, MAVIR, SEPS, CREOS

Country	TSO	Quarter of accession
Slovenia	ELES	Q1 2019
Croatia	HOPS	Q1 2019
Serbia	EMS	Q2 2019
Bulgaria	ESO	Q3 2019
Greece	ADMIE	Q3 2019
Poland	PSE	Q3/Q4 2019
Spain	REE	Q3/Q4 2019
Portugal	REN	Q3/Q4 2019
Romania	Transelectrica	Q4 2019
Hungary	MAVIR	Q4 2019
Italy	TERNA	Q4 2019
Slovakia	SEPS	Q4 2019

WB6 Implementation roadmap

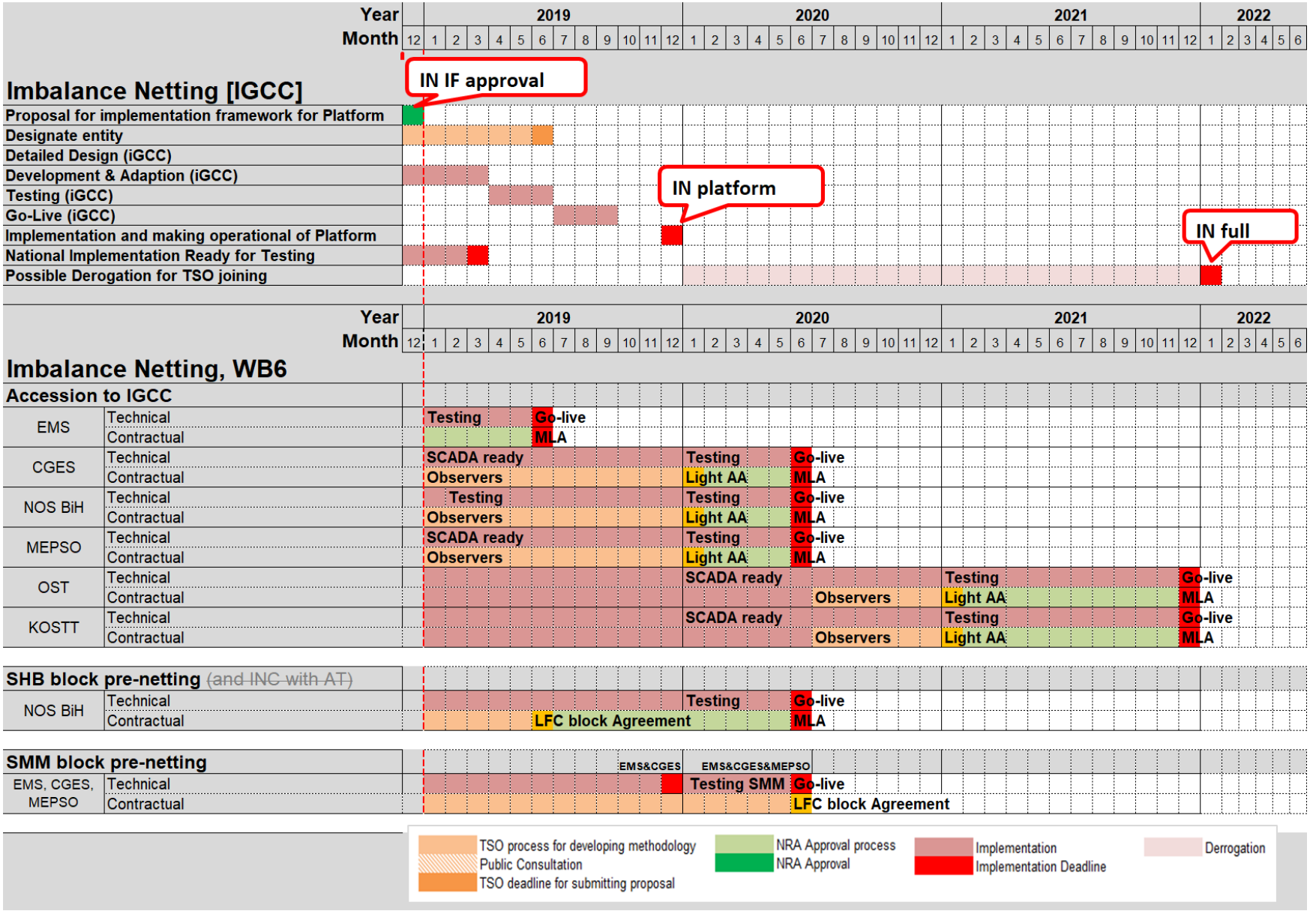
Key message is, that WB6 parties can and should exploit the existence of LFC block(s) and perform pre-netting within each LFC block (subordinated to IGCC)

- SMM, SHB
- possibly perform one pre-netting among LFC blocks, and
- **inevitably go towards the IGCC project**



No	Action item	No	Action item
1	all TSOs to **approach towards the IGCC**, as soon as possible As: - Observers - Non-operating members - Operating members	2	**formal formation of LFC blocks** (SMM, SHB) under propositions of SO GL as described in Task 2 Report
		3	**In parallel to IGCC, SHB block (incl. NOS BiH)** to apply pre-netting
		4	**SMM block** to apply (pre)netting EMS and CGES practically ready
		5	Optional: additional pre-netting optimisation region (one more allowed): - SHB with SMM, OST with KOSTT, SMM with OST or KOSTT

IN implementation roadmap



mFRR/RR energy exchange

- Task 4 summary: model, analyses, benefits
- Task 5: mFRR/RR Implementation roadmap

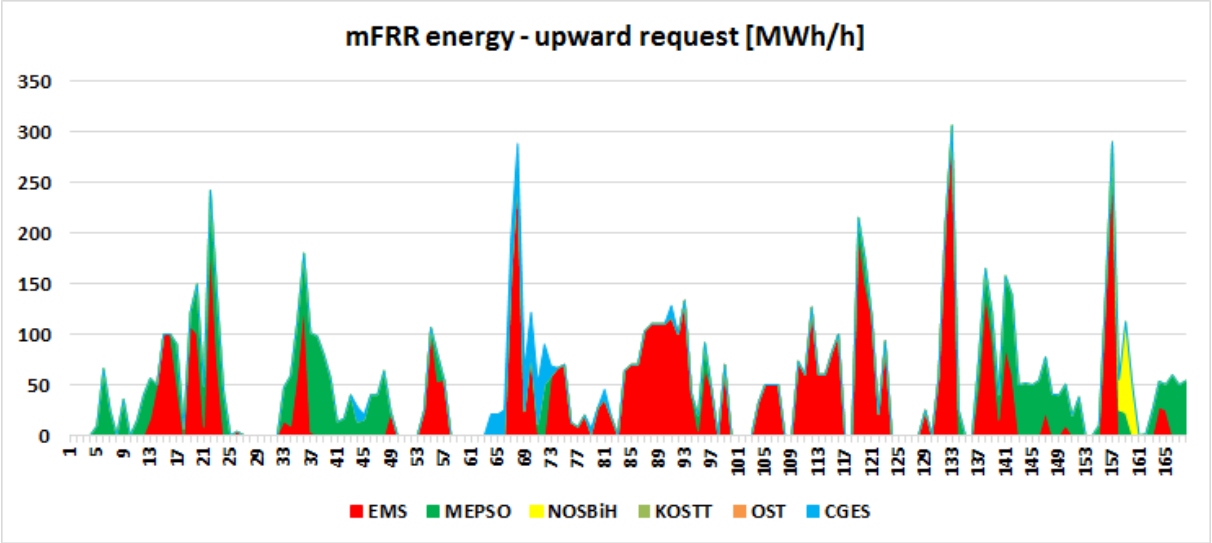
mFRR/RR in WB6 cooperation: key facts

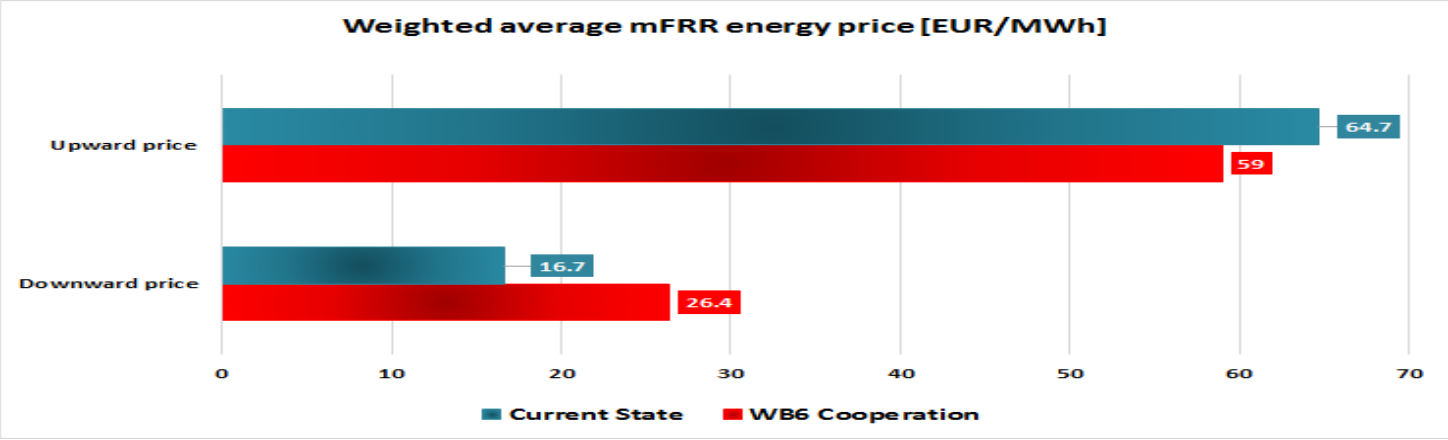
- **Standard product:**
  - **in line with MARI (mFRR Schedulled Act., Direct Act.) and TERRE,**
  - **tailored to temporary take into account actuall specifics of WB6 region**
    - Min duration SA mFRR: MARI 5 min WB6 50 min
    - Min duration RR: TERRE 15 min WB6 60 min
- **Synchronised Gate Open / Closure Times for activations and bidding at Common Merit Order List**

  BSP->TSO bids submission:
  - RR bids: 55-36 minutes before the real time
  - mFRR bids: 25-10 minutes before real time
- **TSO-TSO volume for settlement of exchanged balancing energy**
  - mFRR: trapezoid
  - RR: rectangular
- **Cross zonal marginal pricing** – the most expensive bid in non-congested group of areas defines the price

WB6 balancing energy exchange - dry run

- **Simulation software** and WB6 dry run exercised at common mFRR & RR platform, embedding: SA mFRR, DA mFRR, RR
- The dry run was performed on the basis of TSOs' data for period **16th -22nd of July 2018**





Indicative estimation of annual benefits in WB6 ≈ EUR 4.3 million/year

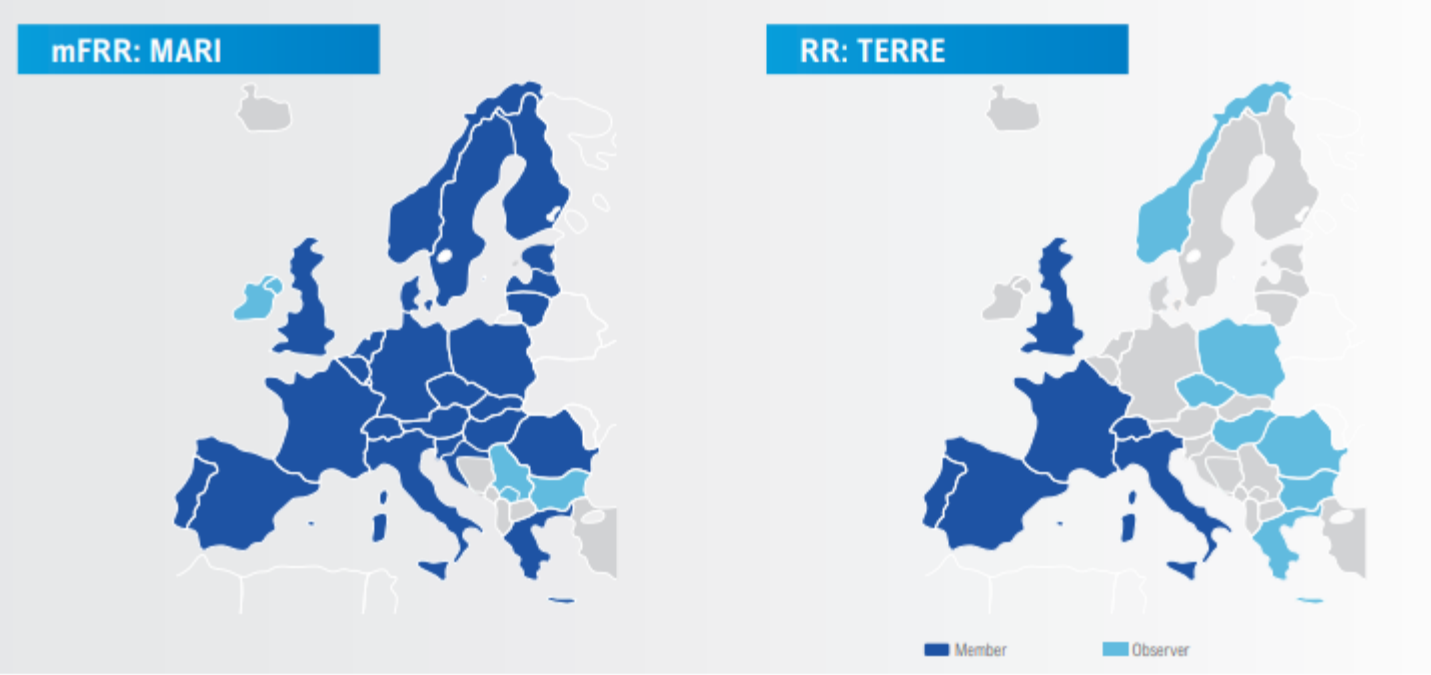
mFRR & RR integration – process in Europe

Manually Activated Reserves Initiative (MARI) is the European implementation project for the creation of the European mFRR platform.

According to EB GL (Art.20) and MFRRIF (Art.1), pan-European **mFRR energy exchange** process, and consequential **MARI platform** is considered **mandatory** for all TSOs.

Trans European Replacement Reserves Exchange (TERRE) is the European implementation project for exchanging replacement reserves.

According to EB GL (Art.19, Art.31) and MFRRIF (Art.1), pan-European **RR energy exchange** process, and consequential **TERRE platform** is considered **optional** for all TSOs.



European process and WB6 regional characteristics

WB6 regional characteristics

- In the WB6 region, "tertiary control" (mFRR&RR) primary deployed by EMS (to keep required band for aFRR), with some of the TSOs (OST, NOSBiH) relying more on aFRR and rarely activating "tertiary control"

- RR is rarely used in the product format which is recognized within EB GL. It is usually treated as an "emergency" energy import for the largest outages

- mFRR process with 2 products and RR process with 1 product, to large extent **share the similar timeframe and triggering events**, therefore the **application of all three "tertiary control" models in parallel seems complex and not justified at this stage**

The aim is to find pragmatic and feasible solution for mFRR & RR energy exchange cooperation in WB6 region

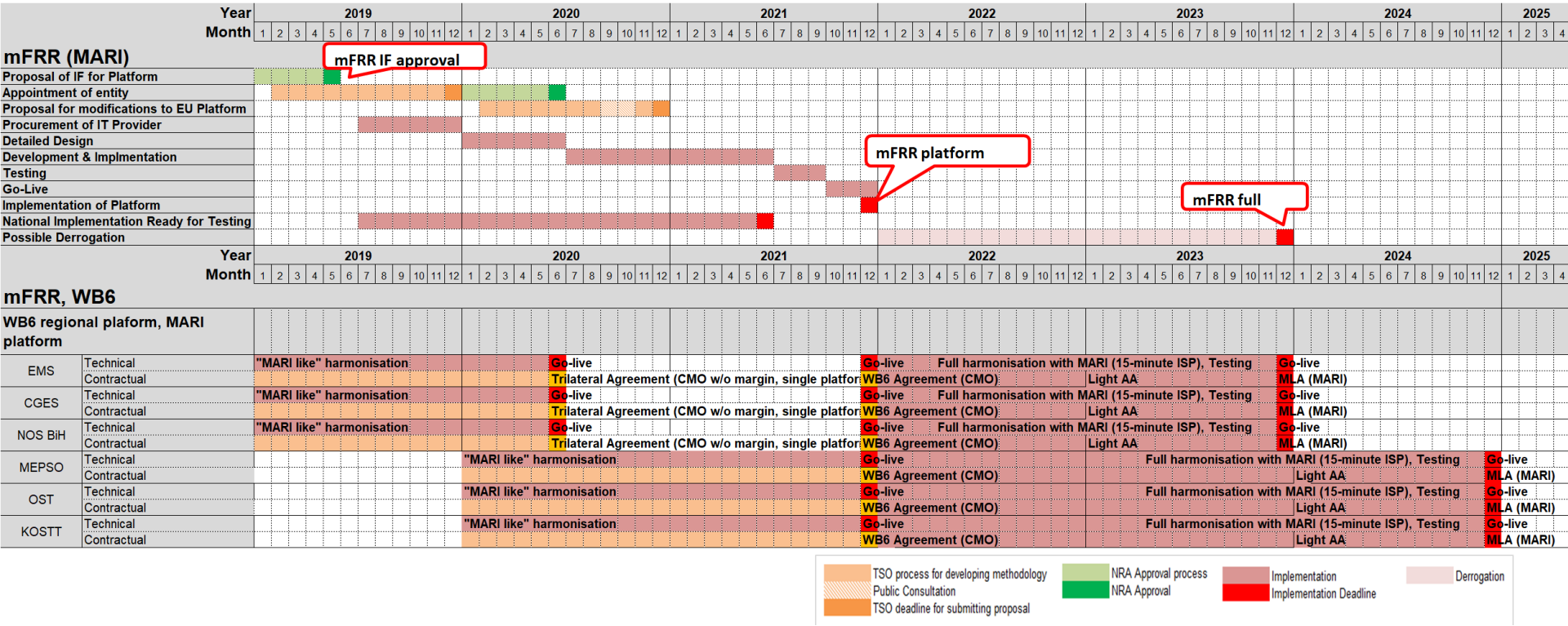
Pragmatic mFRR and RR solution for WB6 region

mFRR cooperation	• To be set as **mFRR energy exchange with two products: schedule activated mFRR and directly activated mFRR** (as described in Task 4) • **Initially at regional level**, with gradual extension within the region, and as well **moving towards the full participation in MARI project**
RR cooperation	• Markets are generally moving closer to real time, which includes more active **intra-day commercial trade that can replace RR activations** • Therefore, **establishment of RR cooperation in WB6 region should not be the primary objective**, but rather to remain as the additional possibility for those TSOs who opt to apply such mode of control on national level

WB6 cooperation: Integration roadmap

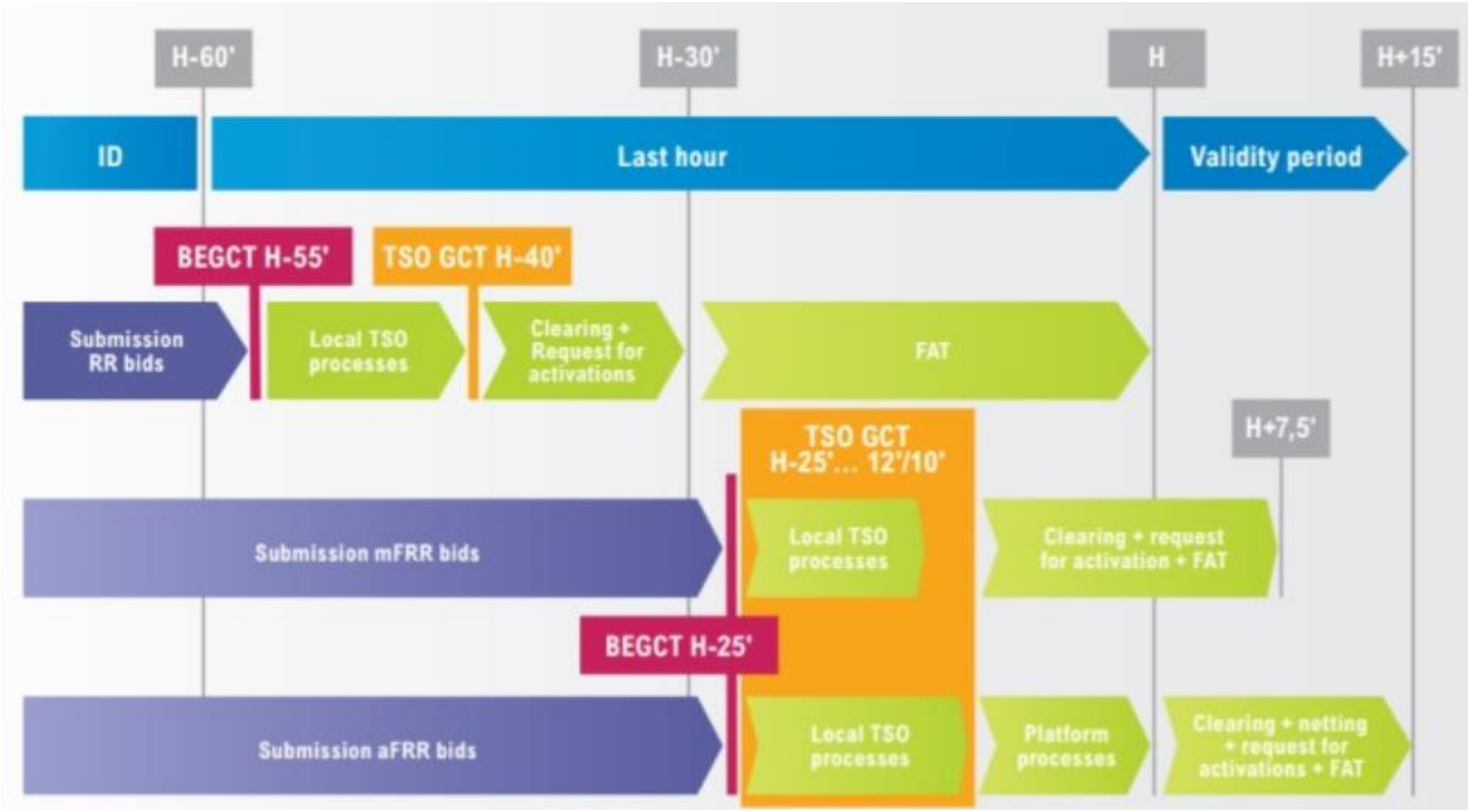
No	Action item
1	Initial Step: **Harmonisation of standard product for SA and DA mFRR** as described in Task 4 Report
2	Regional 1: **EMS, CGES and NOS BiH at single platform and CMOL** From several bilateral cooperations -> multilateral agreement and single activation optimisation platform with common merit order list
3	Regional 2: **Transformation of "Regional 1" platform (EMS, NOSBIH and CGES) into full WB6 cooperation** OST, MEPSO and KOSTT to join once they are ready from the organisational and technical point of view
4	European: **Full integration of WB6 region with MARI** The main target is that all WB6 TSOs should join MARI project and transition from regional cooperation to Pan-European should be preferably grouped together or individually, TSO by TSO, in accordance with the level of compliance

Integration roadmap for WB6 region - timeline



BACKUP SLIDES (mFRR/RR)

The balancing energy gate closure time (BE GCT) is the point in time at which BSPs are no longer permitted to submit or update a balancing energy bid to their connecting TSO. The BE GCT for BSPs and the TSO GCTs shall be distinguished - first BSPs send and update their bids until BE GCT, after which all submitted bids should be firm, and subsequently TSOs forward the bids to the relevant platforms until a certain point in time - TSO energy bid submission GCT (TSO GCT). An individual BE GCT is defined for each balancing energy product. Figure 5 summarises the TSO proposals for BE GCTs and TSO GCTs, whilst taking into account the interactions with other balancing processes.



LFC blocks: Gap analysis

LFC BLOCK POTENTIAL/RESPONSIBILITY IN ACCORDANCE WITH SO GL and EB GL

Task 2 Report provides comprehensive gap analysis per blocks (primarily versus SO GL):

Compliant/Partially compliant/Missing

4.3 TSO cooperation – Albania and Kosovo*

4.2 LFC Block - SHB (Slovenia, Croatia and BiH)

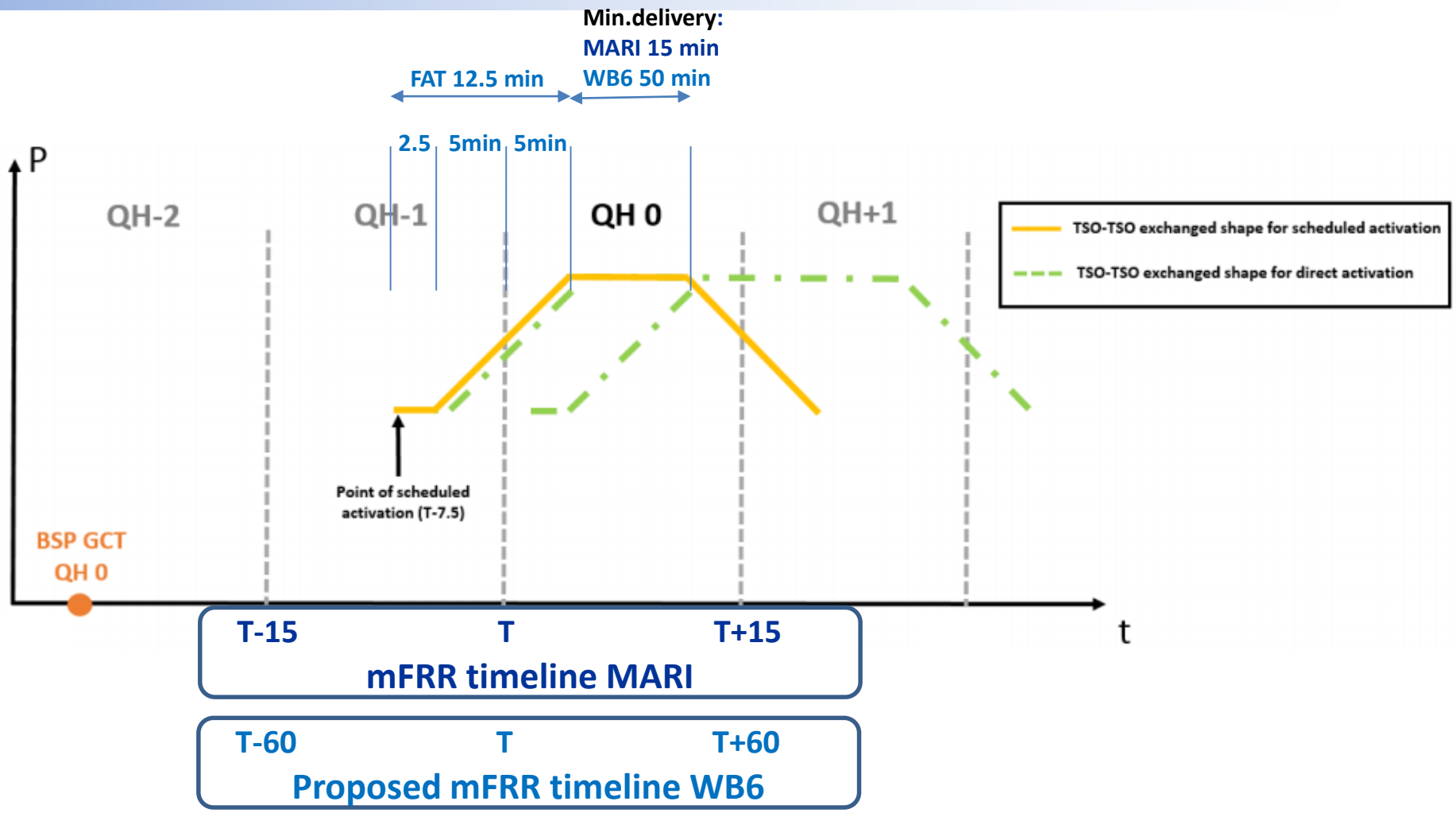
4.1 LFC Block - SMM (Serbia, Montenegro and Macedonia)

SO GL	Current operational practice / Operational agreements	Level of compliance	Proposed changes
LFC Operational Agreement	The existing operational agreement does not include all requirements listed in Chapter 3.2. It mainly covers only general terms and conditions for LFC Block arrangements.	Partially compliant	TSOs within SMM Block shall adopt new operational agreement that will comprise all requirements listed in Chapter 3.2 in accordance with SO GL.
Article 119 (Paragraph 1a) - Definition of FRCE target parameters for each LFC area	FRCE target parameters are not defined for each LFC area within SMM block.	Missing	Once FRCE target parameters are defined on the level of CE

- **LFC Operational Agreement:** Basic agreements exist; need to be updated with more stringent, obligatory terms and conditions
- **Allocation of responsibilities among TSOs in LFC Block;** to comply with FRR and RR dimensioning principles (common dimensioning)
- **Operational procedures, requirements, definitions**
- **FRR and RR availability requirements**
- **Control quality requirements for BSPs**
- **Operational procedures in case of exhausted FRR/RR**

TSOs are obliged to submit adopted methodologies and procedures for approval by all the regulatory authorities of the concerned LFC Block

WB6 cooperation – proposed mFRR energy product



Integration roadmap for WB6 region

- In addition to the balancing energy exchange cooperation, **the balancing reserve-related integration** process in terms of:
  - Common dimensioning for LFC blocks (SMM, SHB)
  - Reserve sharing among LFC Blocks
  - Reserve exchange to facilitate reserve requirements (KOSTT)

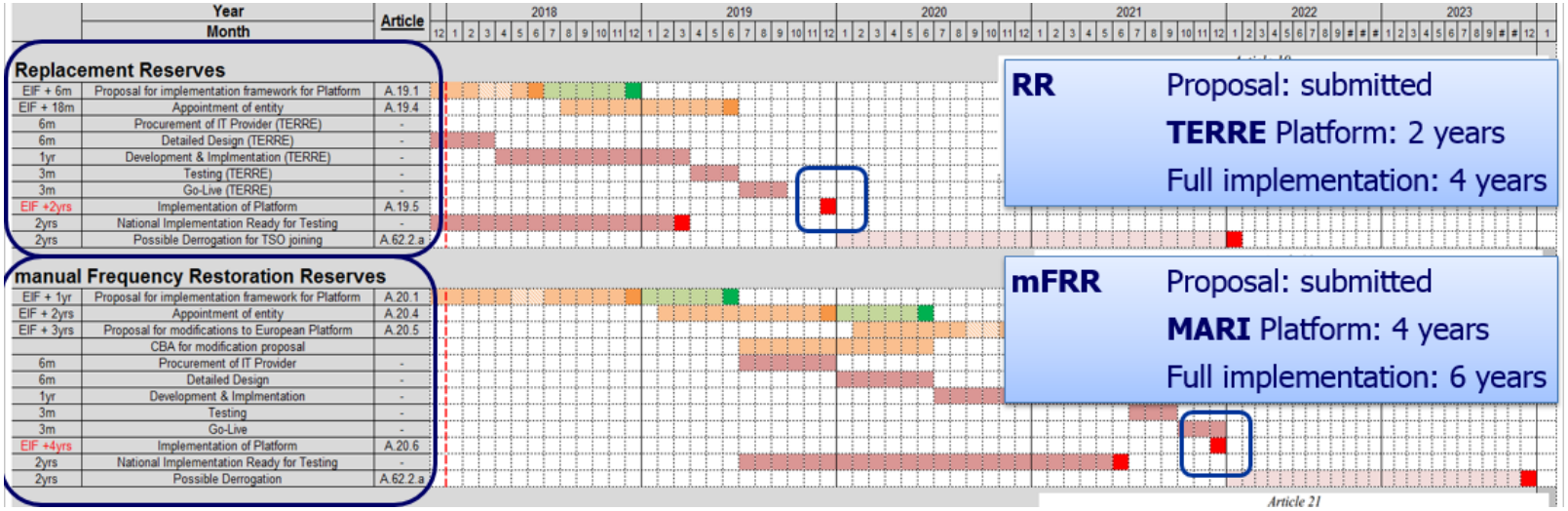
is also welcomed and desired approach **since it contributes to proper setup of national and regional balancing markets and facilitates more liquid regional balancing energy exchange**

mFRR and RR balancing energy services

Balancing service	Previous name in ENTSO-E CE (UCTE OH)	Activation method	Time domain of response
Frequency Containment Reserve **(FCR)**	**Primary** control reserve	Automatic	Up to 30 seconds
Automatic Frequency Restoration Reserve **(aFRR)**	**Secondary** control reserve	Automatic	Up to 5/7.5 minutes
Manual Frequency Restoration Reserve **(mFRR)**	Fast **tertiary** control reserve (DA - Directly activated) (SA - Schedule-activated)	Manual	Up to 12.5 minutes
Replacement Reserves **(RR)**	Slow **tertiary** control reserve	Manual	30 minutes

WB6 COOPERATION

EU process for mFRR & RR energy exchange:



WB6 cooperation – proposed standard products

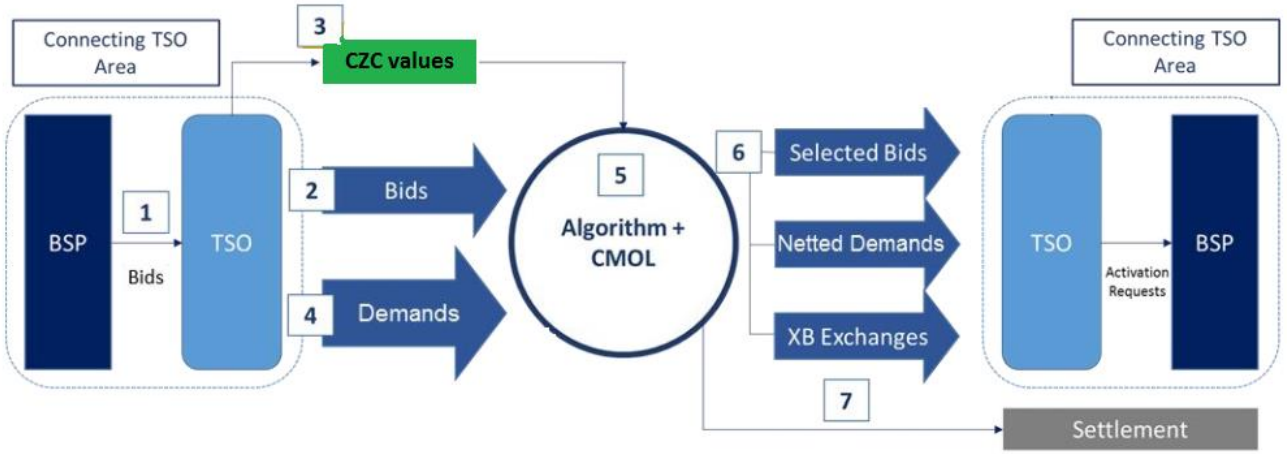
Standard product tailored to address **key requirements defined by EB GL** and **relevant draft Implementation Frameworks (MFRRIF, RRIF)**, as well as to take into account the **specific characteristics of WB6 region**

Main mFRR product features	ENTSO-E MARI proposal for mFRR standard product to be exchanged on the Platform	Proposal for WB6 cooperation and mFRR standard product to be exchanged on the Platform
Mode of activation	Manual	Manual
Activation type	Direct or Scheduled	Direct or Scheduled
Full activation time ("FAT")	12.5 minutes	12.5 minutes
Minimum quantity	1 MW	1 MW
Bid granularity	1 MW	1 MW
Maximum quantity	9999 MW	9999 MW
Minimum duration of delivery period	5 minutes (SA mFRR)	50 minutes* (SA mFRR)
Validity Period	Scheduled activation can take place at the point of scheduled activation only (T-7.5minutes). Direct activation can take place in any period of time between two points of schedule activation.	Scheduled activation can take place at the point of scheduled activation only (T-7.5minutes). Direct activation can take place in any period of time between two points of schedule activation.
Price	in EUR/MWh	in EUR/MWh
Price resolution	0.01 EUR/MWh	0.01 EUR/MWh
Location	At least the smallest of LFC area or bidding zone.	At least the smallest of LFC area or bidding zone.

Main RR product features	ENTSO-E TERRE proposal for RR standard product to be exchanged on the Platform	Proposal for WB6 cooperation and RR standard product to be exchanged on the Platform
Mode of activation	Manual and Scheduled	Manual and Scheduled
Preparation Period	From 0 to 30min	From 0 to 30min
Ramping period	From 0 to 30min	From 0 to 30min
Full activation time ("FAT")	30 minutes	30 minutes
Deactivation period	Under national responsibility	Under national responsibility
Minimum quantity	1 MW	1 MW
Minimum duration of delivery period	15 minutes	60 minutes*
Location	Bidding Zone	Bidding Zone
Validity Period	Defined by BSP and respecting the min and max delivery period.	Defined by BSP and respecting the min and max delivery period.
Price	in EUR/MWh	in EUR/MWh

**Since ISP=60min is common and harmonized in all of the WB6 parties, the proposed platform is envisaged to facilitate the suitable product (60min of minimum delivery). After the transition period (and shift to ISP=15min), the WB6 parties are expected to switch to standard product with 15min of minimum delivery) and later join pan-European mFRR platform.*

WB6 cooperation – balancing energy exchange process

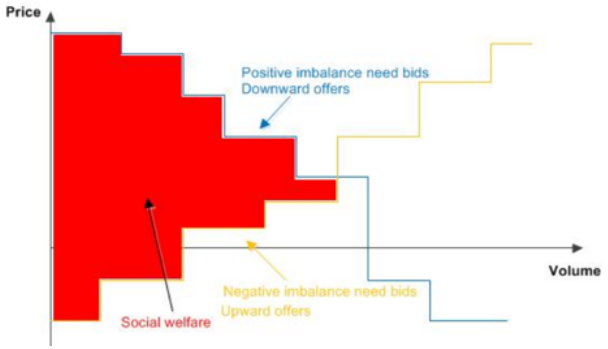


Inputs

- Balancing energy bids
- CZC constraints
- TSOs balancing energy demands

Activation Optimization Function

Objective function: SW maximization



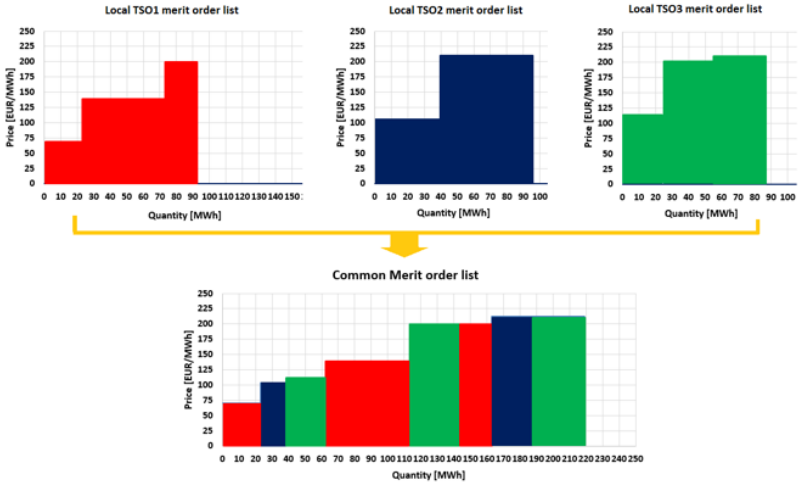
Outputs

- Accepted bids
- Satisfied TSOs demand
- Balancing energy prices
- XB exchanges
- TSO-TSO settlement

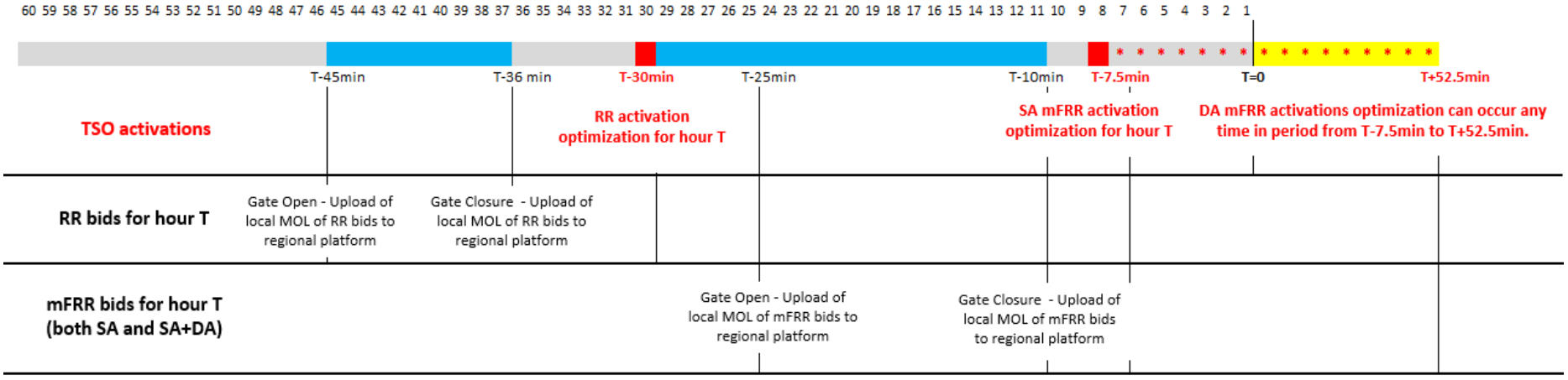
WB6 cooperation – Common Merit Order List

Gate Open---Closure Times for BSP->TSO bids submission:

- RR bids: **55---36 minutes** before the real time
- mFRR bids: **25---10 minutes** before real time



TSO -> platform bids submission & activations:

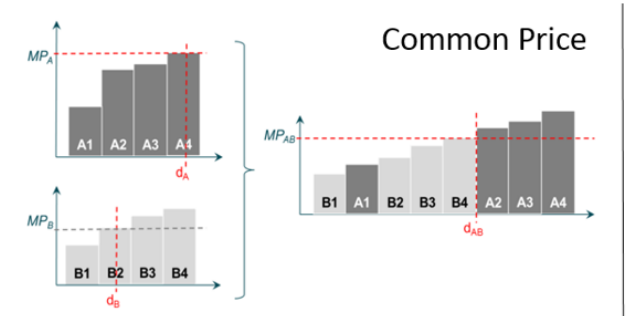


WB6 cooperation – Pricing and Settlement

TSO-TSO volume for settlement of exchanged balancing energy

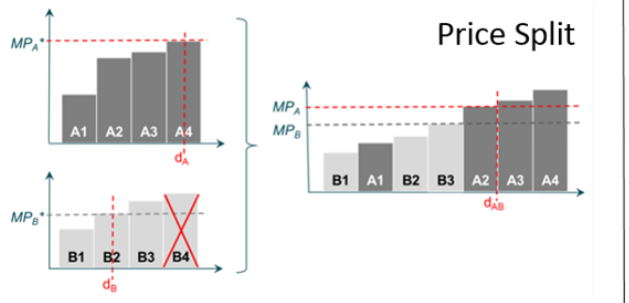
TSO-TSO exchange profile	Illustration
RR - Rectangular shape	
SA mFRR - Trapezoid profile with 10min ramps and 50min duration of activated quantity	
DA mFRR - Trapezoid profile with 10min ramps and duration of activated quantity depending on the activation point	

Cross zonal marginal pricing - the most expensive bid activated in a non-congested area determines the price within all zones in this non-congested area



No Congestion:

Both areas recieve the same price



With Congestion:

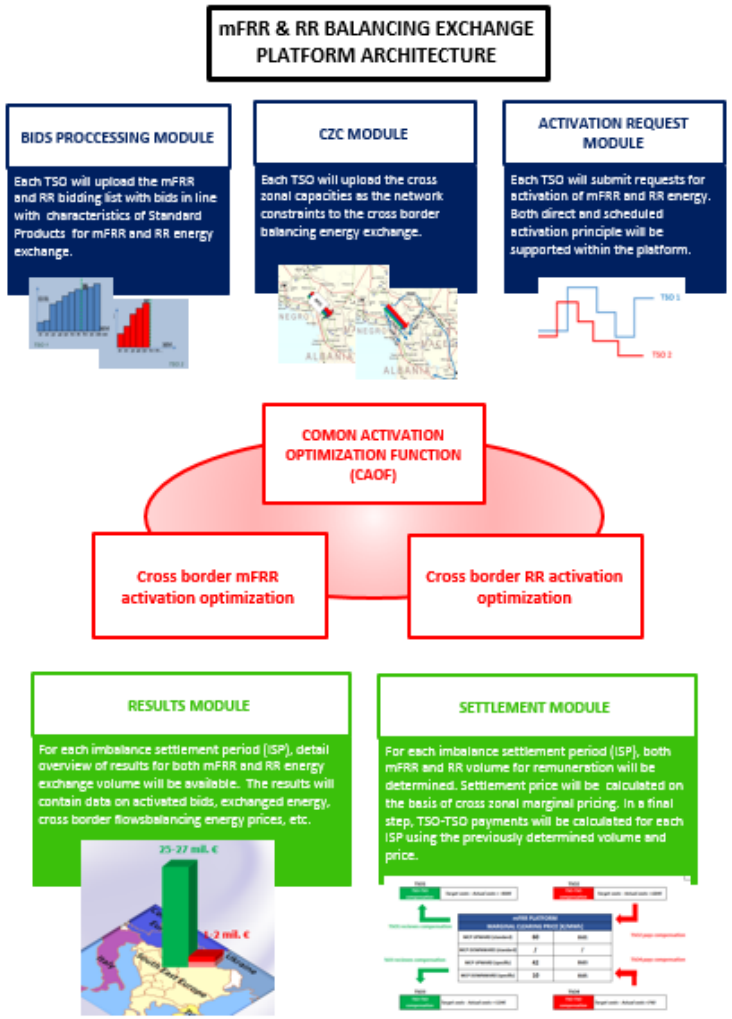
Each area will have it's own price

There is a congestion rent (which is shared between TSOs)

WB6 balancing energy exchange demonstration platform

1 software module

2 markets	3 processes
mFRR	Scheduled activation of mFRR ("SA" mFRR) Direct activation of mFRR ("DA" mFRR)
RR	Replacement Reserve activation (RR)



WB6 balancing energy exchange - dry run

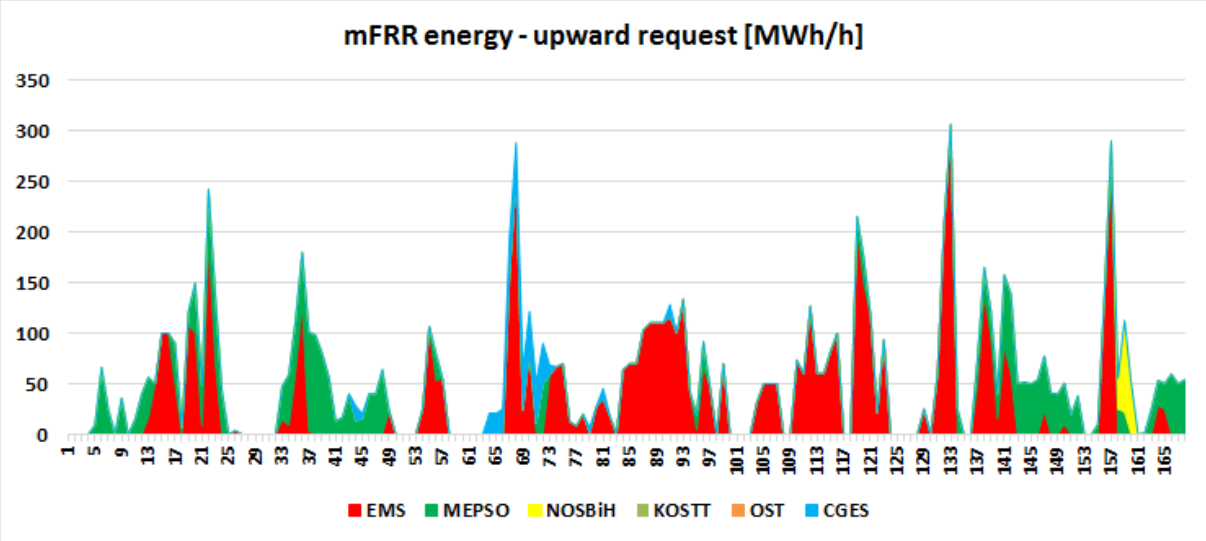
The dry run was performed on the basis of TSOs' data for period:

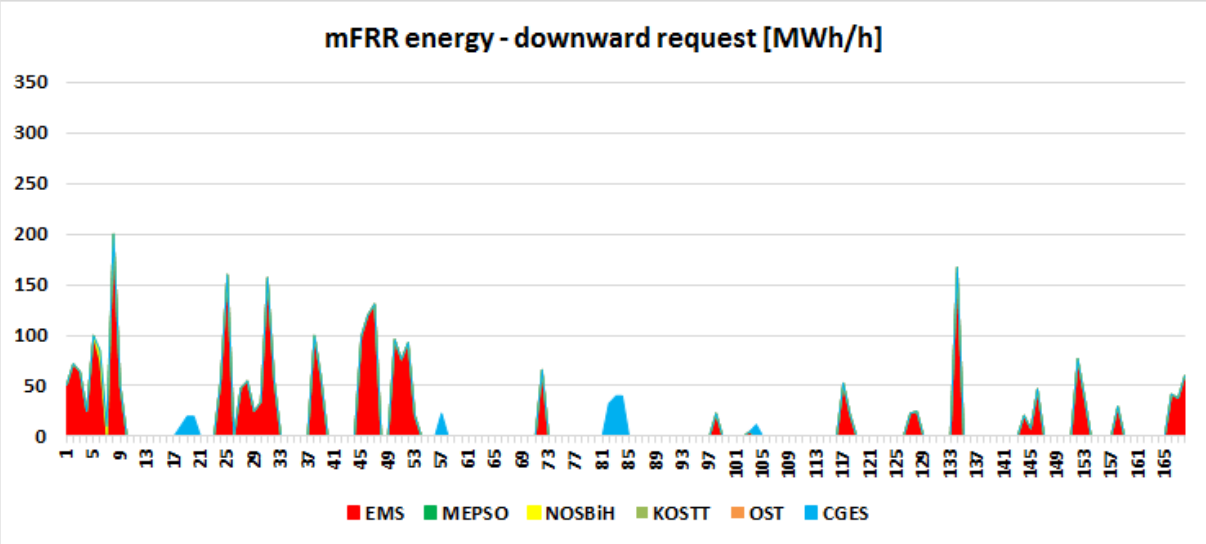
16th -22nd of July 2018

Since:

- **current bidding strategies and observed balancing price formation is still not fully market based in WB6 parties**
- **certain assumptions are made related to the missing data**

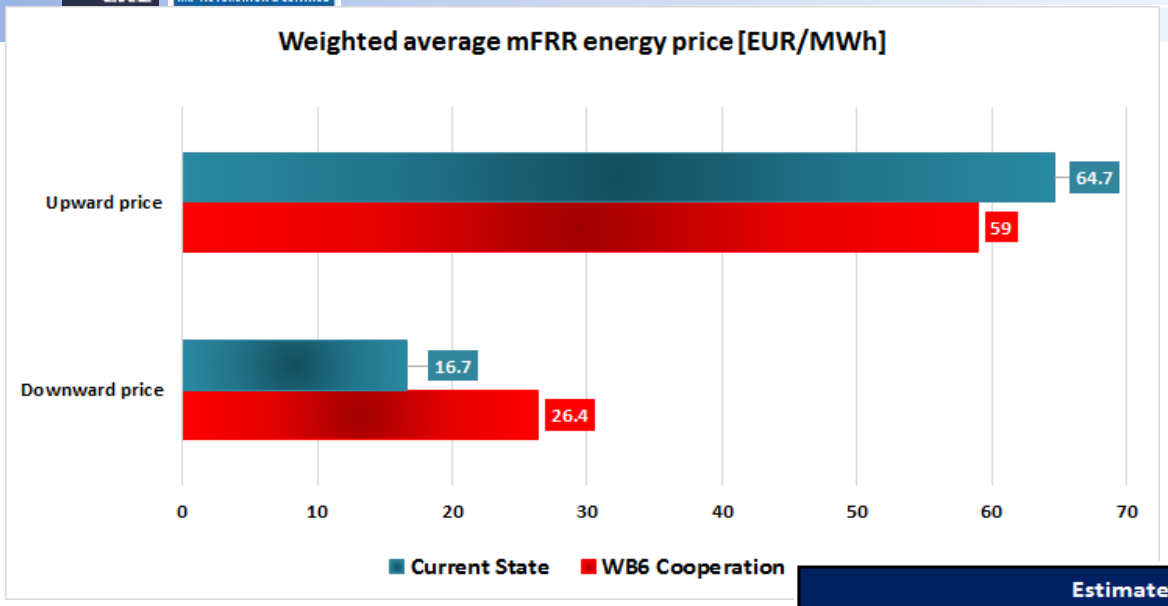
…





…the analyses and consequent numerical results can only be treated as indicative, providing an estimation of the potential savings under regional balancing cooperation

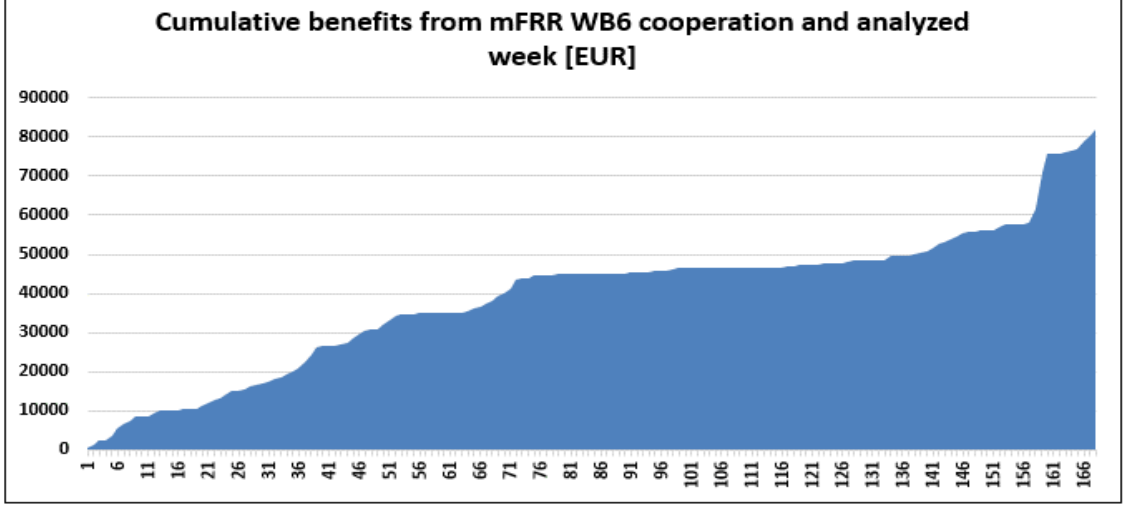
WB6 balancing energy exchange - dry run



The effect on prices:

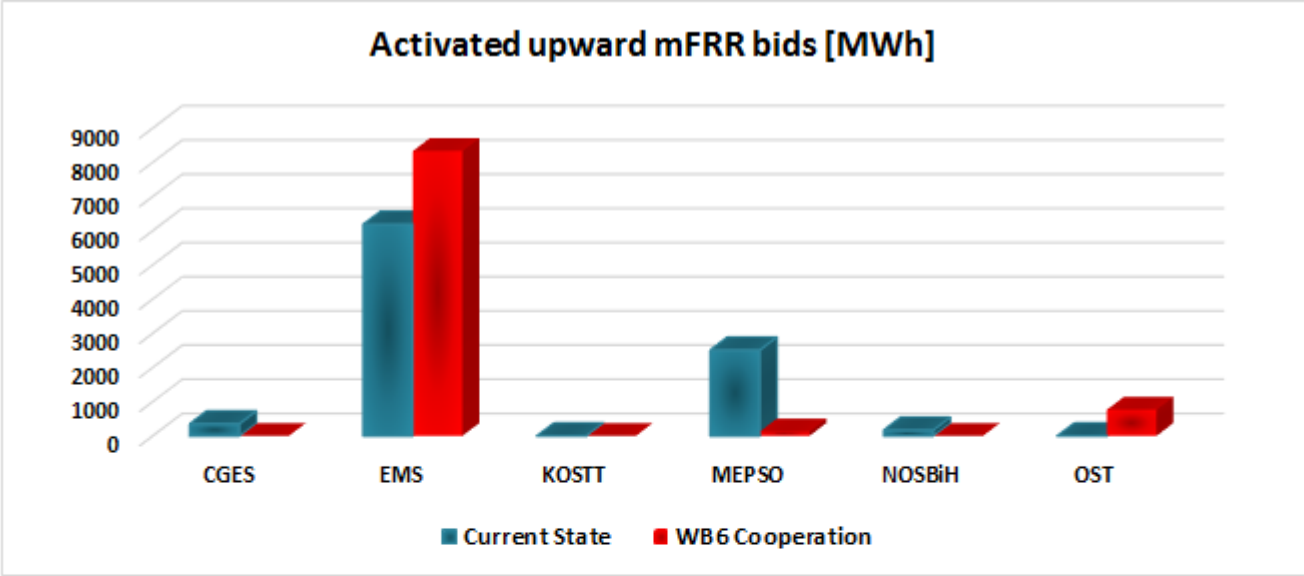
- **mFRR balancing energy price decreases for 5.7 EUR/MWh in upward direction**
- **mFRR balancing energy price increases for 9.7 EUR/MWh in downward direction**

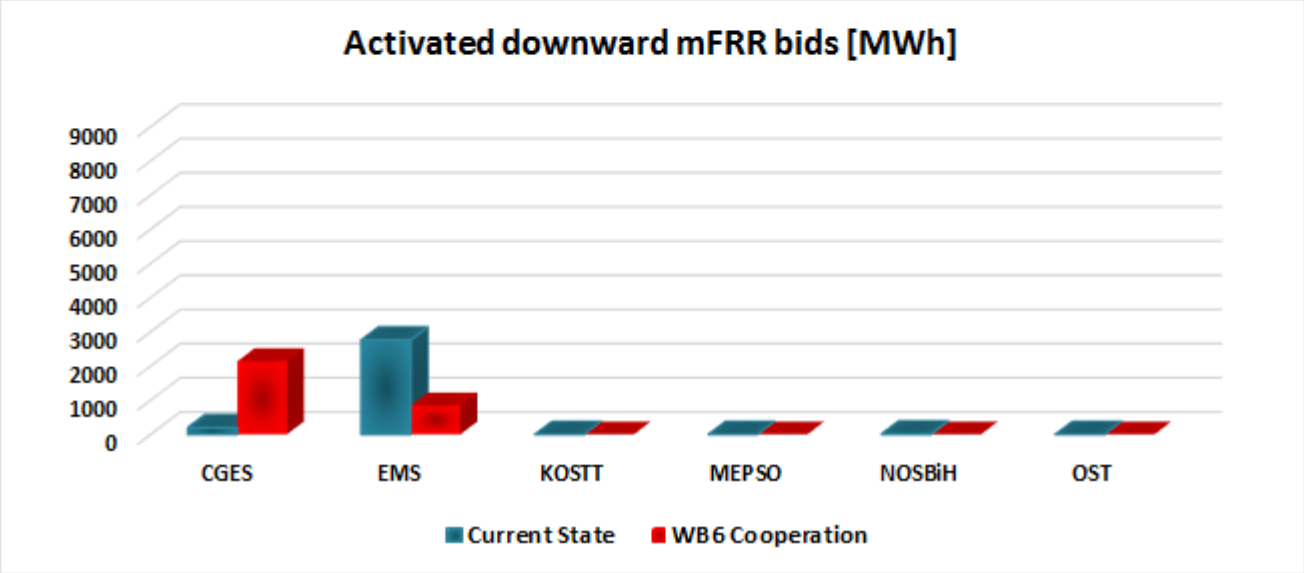
Estimated benefits - mFRR & RR cooperation [EUR]							
Horizon	CGES	EMS	KOSTT	MEPSO	NOSBiH	OST	Sum
Dry run week	22,630	11,450	-	26,805	18,892	2,061	81,838
Annual estimation (WB6 region)							4,267,262



Tentative estimation of annual benefits ≈ EUR 4.3 million per year

WB6 balancing energy exchange - dry run





mFRR: Contractual framework

Contractual framework of regional mFRR energy exchange required to follow the setup of EB GL, mFRRIF and MARI project in particular

For MARI and for regional mFRR exchange:

- **Non-disclosure Agreement (NDA)**
- **Accession Agreement (AA)**
- **Multilateral Agreement (MLA)**

MARI not yet at maturity stage as IGCC, therefore no strong reference documents;

Propositions of MLA, as the key legal act, is based on information from available documents:

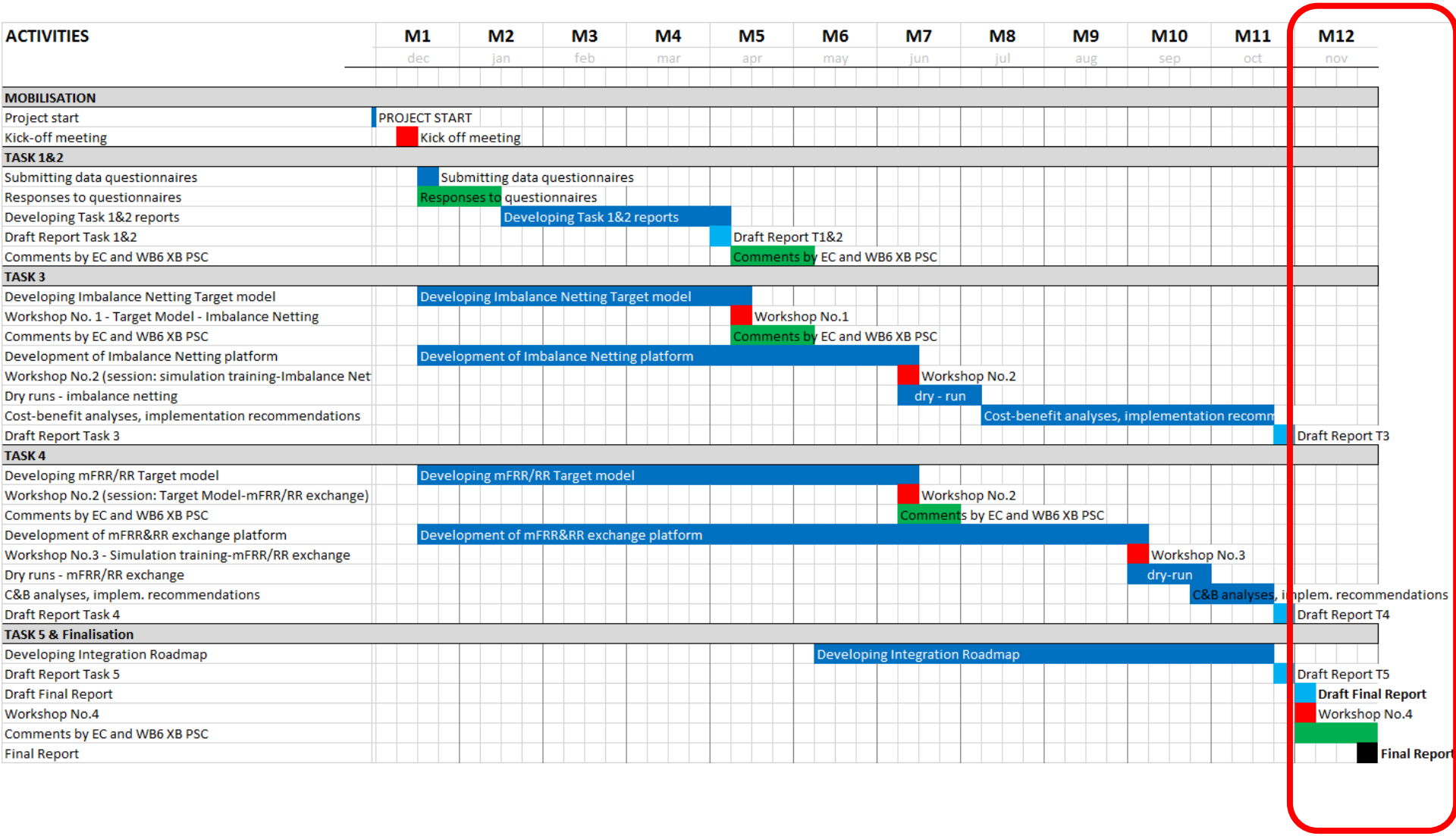
- **EB GL**
- **Implementation framework ("mFRRIF"), by ENTSO-E**
- **mFRRIF's Explanatory Document**
- ***Task 4 report on mFRR model, standard product, algorithm, settlement, IT requirements***
- ***analogy to IGCC framework is used as well***

mFRR MLA: Articles and annexes

ARTICLE/CHAPTER	DESCRIPTION	REFERENCE
Signatories	List of signatory parties; Defining member TSOs	General
Preamble	Introductory points	MFRRIF (11)
Definitions	Definitions of used terms and calculated values	EB GL (8); MFRRIF (11)
Objectives and principles	General objectives, goals and principles of cooperation	MFRRIF (11), (12)
Governance structure	Establishment of two level governance and decision making process: Steering Committee (SC) and Expert Group (EG)	MFRRIF (11), (12)
Decision making	Principles of decision making, representatives, voting	MFRRIF (11), (12)
Cost sharing	Principles of cost sharing among TSOs	MFRRIF (11), (12)
Responsibilities	Definition of responsibilities of member TSOs and host TSO	General
Reduction or suspension of participation	Describing situation of reduction or suspension of participation, by the: mFRR platform / members / affected TSO	General
Standard product	Description of mFRR standard product for SA and DA	Task 4 Report; MFRRIF (11), (12)
Algorithm	Description of the mFRR optimization algorithm	Task 4 Report; MFRRIF (11), (12)
Limitations	Principles of and applying the transmission constraints: CZC, incl. pricing	Task 4 Report; MFRRIF (11), (12)
Data exchange	Data exchanged in IGCC among participating TSOs and host TSO: bids, demands, limitations, HVDC loss (MARI), Settlement and accounting, outputs	Task 4 Report; MFRRIF EN (12)
Settlement	Settlement and accounting principles	Task 4 Report; MFRRIF (11), (12)
Non-disclosure rules	Principles of protection of confidential information	General
Liabilities	Liabilities towards other members and towards third parties	General
Force majeure	Recognising Force majeure situations and related suspension of MLA obligations	General
Adaptations	Recognizing the needs for adaptation of main MLA documents and Annexes, mainly in relation to future expansion	General
Termination	Principles of MLA termination by participating TSOs	General

BACKUP SLIDES
(general)

Time schedule



European processes in establishing XB balancing cooperation

Linkage of GLEB obligations and 4 related processes

Reference to 3 processes under WB6 XBB project

Electricity Balancing Guidelines (GLEB)	Process	Proposal by TSOs	Status	Platform to be ready	Host platform / project	WB6 XBB project:	
						Target model	Demo platform
Adopted December 2018	**Imbalance Netting**	Nov 2017	submitted to ACER and EC (Jun18)	End 2019	**IGCC**	**IN draft (Apr) ✓**	**IN platform (July) ✓**
	Exchange of aFRR	March 2018	public consultation	End 2021	PICASSO	/	/
	Exchange of mFRR	May 2018	public consultation	End 2021	**MARI**	**mFRR draft (July) ✓**	**mFRR & RR platform (Sept) ✓**
	Exchange of RR	June 2018	submitted to ACER and EC (Jun18)	End 2019	**TERRE**	**RR draft (July) ✓**	

BACKUP SLIDES
(task 1/2)

Impact of existing Control Blocks on integration

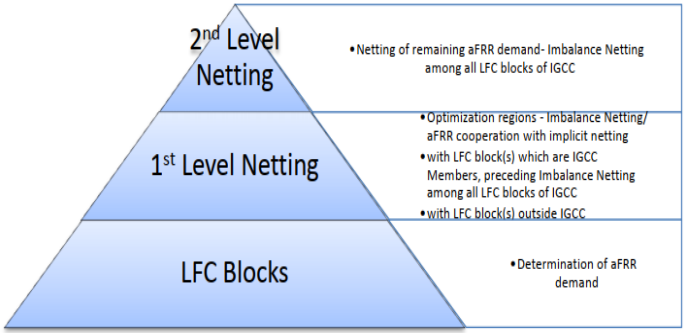
- Current LFControl Blocks in WB6:
  - SMM
  - SHB
- SMM:
  - Secondary (aFRR) control in hierarhical mode (by EMS)
  - Common dimensioning of reserve: EMS and CGES
  - Exchange of tertiary (mFRR/RR) energy
  - Intitiative/pilot of Imbalance Netting
- SHB:
  - Secondary (aFRR) control in pluralistic mode (by ELES)
  - Common dimensioning of reserve
  - Exchange of tertiary (mFRR/RR) energy
  - SI and HR in INC with Austria

BACKUP SLIDES
(IN)

WB6 Implementation roadmap

Key message is, that WB6 parties can and should exploit the existence of LFC block(s) and perform pre-netting within each LFC block (subordinated to IGCC)

- SMM, SHB
- possibly perform one pre-netting among LFC blocks, and
- **inevitably go towards the IGCC project**

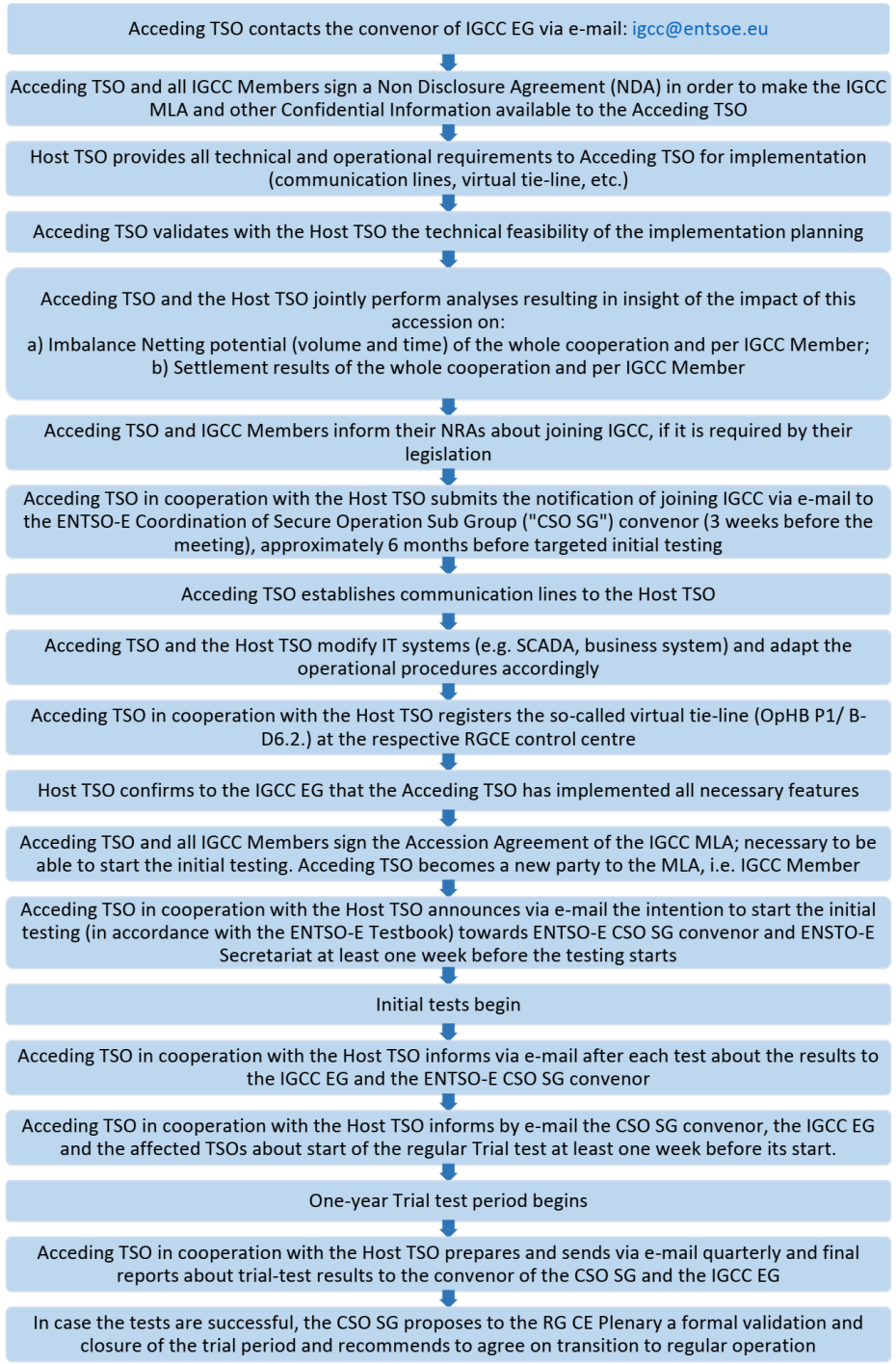


EB GL timeline:

- **Full implementation (all EU TSOs in): Jan 2022**
- **EB GL adaption to EnC: expected during 2020**
- **Mandatory participation of WB6 TSOs in IGCC can then be delayed at least 2 years:**
  - **2022+2: minimally Jan 2024**
- **But, application of IN/IGCC is beneficial even without formal obligation!**

IGCC accession process

"Guide how to become IGCC member" defines IGCC accession steps →



Pre-netting

SO GL, Article 146:

"Where a LFC block consists of more than one LFC area and the reserve capacity on FRR as well as the reserve capacity on RR is calculated based on the LFC block imbalances, all TSOs of the same LFC block shall implement an imbalance netting process and interchange the maximum amount of imbalance netting power defined in paragraph 6 with other LFC areas of the same LFC block"

INIF document, Article 11.2:

"each member TSO belonging to an LFC block shall have the right to perform imbalance netting with the other TSO(s) of the same LFC block prior the imbalance netting with other LFC blocks and, by this, have prior access to the transmission capacity within the LFC block. Imbalance netting within an LFC block is not considered as an optimization region"

IGCC stakeholder document:

"... In case TSOs perform a common dimensioning (LFC Block), pre-netting is necessary to favor the access to the transmission capacities for aFRR activation. Without pre-netting within LFC Block the transmission capacity might be already used for imbalance netting between non-LFC Block members. Therefore, the **pre-netting is considered mandatory in a LFC Block**"

Pre-netting

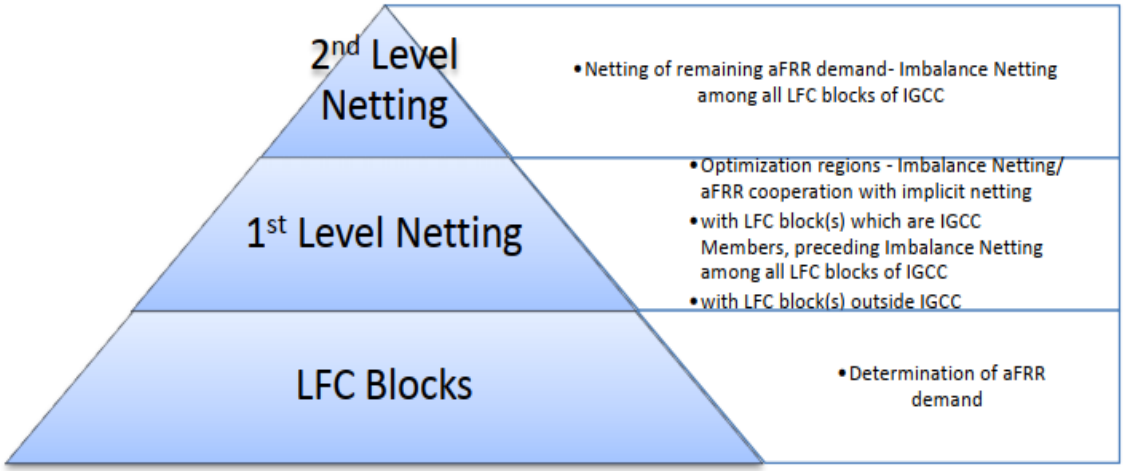
Optimisation region

… is two or more LFC blocks, applying either:

- imbalance netting, (explicit pre-netting) or
- the exchange of aFRR over CMOL (and, by this, implicit netting embedded)

Internal LFC block pre-netting (as practically mandatory), is not seen as the Optimisation Region

Allowed netting layers:



⇒ **possible:** **- internal LFC block pre-netting**

- Opt. region: one pre-netting among LFC blocks (or aFRR CMOL)

- finally, IGCC

IN: Contractual framework

For IGCC and/or for LFC block level pre-netting:

- **Non-disclosure Agreement (NDA)**
- **Accession Agreement (AA)**
- **Multilateral Agreement (MLA)**

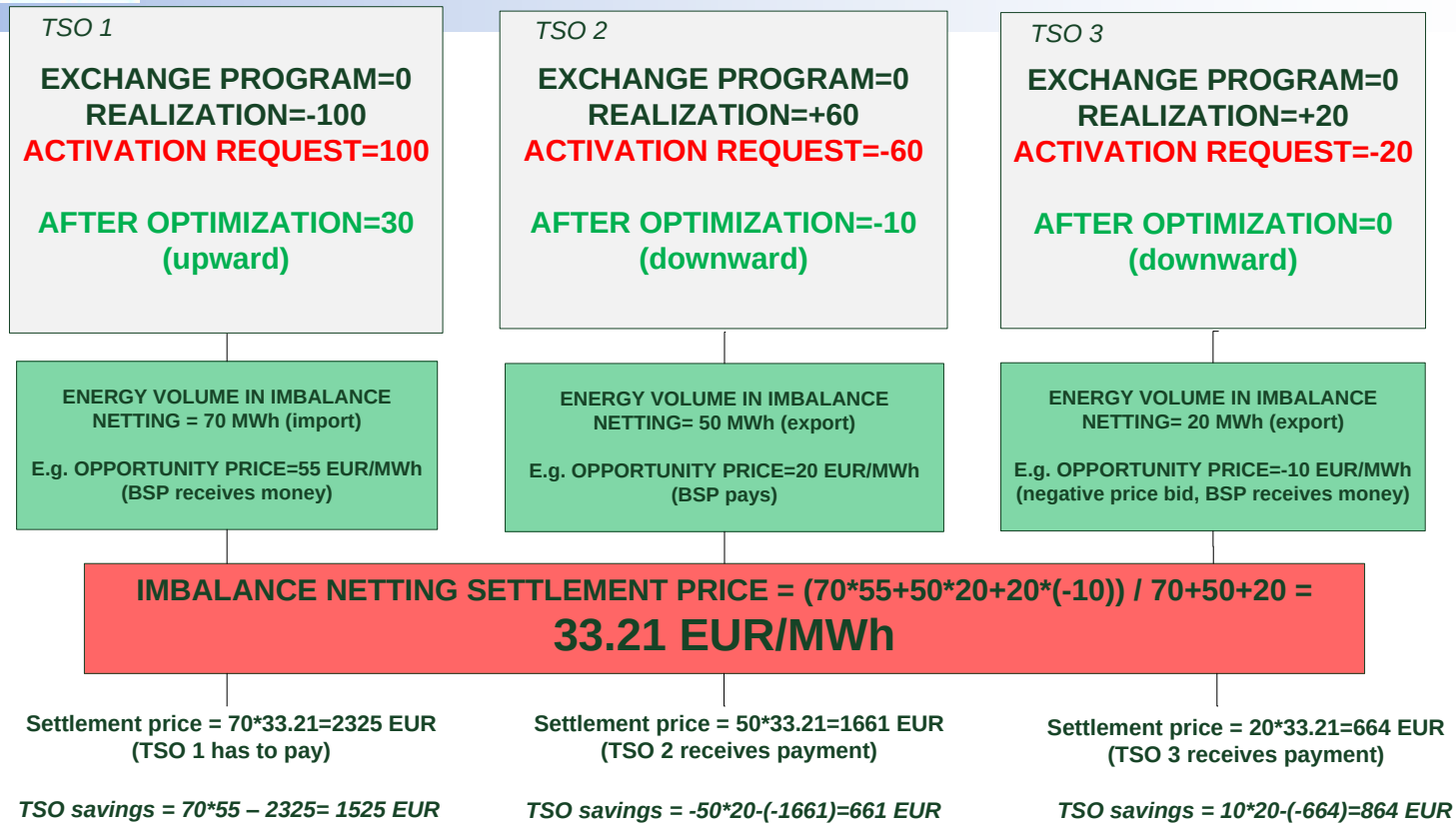
Propositions of MLA, as the key legal act, is based on information from available documents:

- **EB GL**
- **Implementation framework ("INIF"), by all TSOs / ENTSO-E**
- **INIF's Explanatory Document**
- **IGCC stakeholders document for the principles of IGCC**
- **IGCC document on Opportunity prices**
- **ENTSO-E OH**
- ***Task 3 report: Imbalance Netting model, algorithm, settlement, IT requirements***

IN MLA: Articles and annexes

ARTICLE/CHAPTER	DESCRIPTION	REFERENCE
Signatories	List of signatory parties; Defining member TSOs	
Preamble	Introductory points	Stakeholder doc (4); INIF (2)
Definitions	Definitions of used terms and calculated values	EB GL (8); INIF (2); Stakeholder doc (4)
Objectives and principles	General objectives, goals and principles of cooperation	Stakeholder doc (4); INIF (2)
Governance structure	At IGCC, MLA establishes two level governance and decision making process: Steering Committee (SC) and Expert Group (EG); applicable to LFC block IN as well	Stakeholder doc (4); INIF (2)
Decision making	Principles of decision making, representatives, voting rounds	Stakeholder doc (4); INIF (2)
Cost sharing	Principles of cost sharing among TSOs	INIF (2); Stakeholder doc (4)
Responsibilities	Definition of responsibilities of member TSOs and host TSO	Stakeholder doc (4)
Reduction or suspension of participation	Describing situation of reduction or suspension of participation, by the: aFRR optimization system / members / affected TSO	Stakeholder doc (4)
Optimization regions / pre-netting	Rights and obligations regarding pre-netting (at LFC block, implicit pre-netting within aFRR exchange, inter-block pre-netting); as described in Chapter 2.1	INIF (2); Stakeholder doc (4)
Algorithm	Description of the IN optimization algorithm and integration in the local LFC loop	Stakeholder doc (4); *Task 3 Report*
Limitations	Principles of and applying the transmission constraints: ATC, Profile limit, FB limit	Stakeholder doc (4)
Data exchange	Data exchanged in IGCC among participating TSOs and host TSO: Real time data (signals, status) / Limitations / Opportunity prices / Settlement and accounting data	Stakeholder doc (4); ENTSO-E OH Policy 1, Policy 2; *Task 3 Report*
Settlement	Settlement and accounting principles, incl. definition of opportunity prices for each TSO	Stakeholder doc (4); Opp. prices (5); ENTSOE Acc/Sett (6); *Task 3 Report*
Non-disclosure rules	Principles of protection of confidential information	General
Liabilities	Liabilities towards other members and towards third parties	General
Force majeure	Recognising Force majeure situations and related suspension of MLA obligations	General
Adaptations	Recognizing the needs for adaptation of main MLA documents and Annexes, mainly in relation to future expansion	Stakeholder doc (4); Guide on how to become IGCC member (1)
Termination	Principles of MLA termination by participating TSOs	General

IN: settlement example



- TSO 1 "imports" 70 MWh (=100-30), with opportunity price of 55 EUR/MWh
- TSO 2 "exports" 50 MWh (=60-10), with opportunity price of 20 EUR/MWh
- TSO 3 "exports" 20 MWh (=20-0), with opportunity price of -10 EUR/MWh (e.g. negative price)

Imbalance netting settlement price

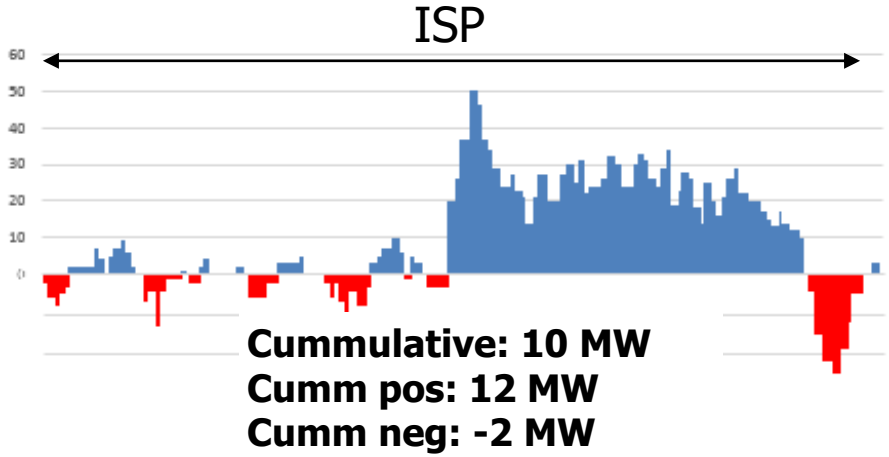
$$\frac{(70*55+50*20+20*(-10))}{70+55+20} = 33.21 \text{ EUR/MWh}$$

Savings:

TSO 1 = 70*55 – 70*33.21 = 1525 EUR
TSO 2 = -50*20 – (-50)*33.21 = 661 EUR
TSO 3 = -20*(-10) – (-20)*33.21 = 864 EUR

IN: settlement

Previous example given in a "snapshot" of data



In reality, within one ISP, TSO can have both positive and negative demand

Options for settlement:

1. **To net the positive/negative activations (then to treat "dominant direction")**

2. **To separately account positive and negative portions (thus to apply 2 opportunity prices per TSO, per ISP)**

IN: Used data (Opportunity prices)

Prices: **CGES – Provided data for aFRR upward and downward**

NOSBIH - Provided data for aFRR upward and downward

EMS – Average price for aFRR upward and downward in period from January to April

MEPSO – Assumed data for aFRR upward and downward (1.5*HUPX and 0.05*HUPX)

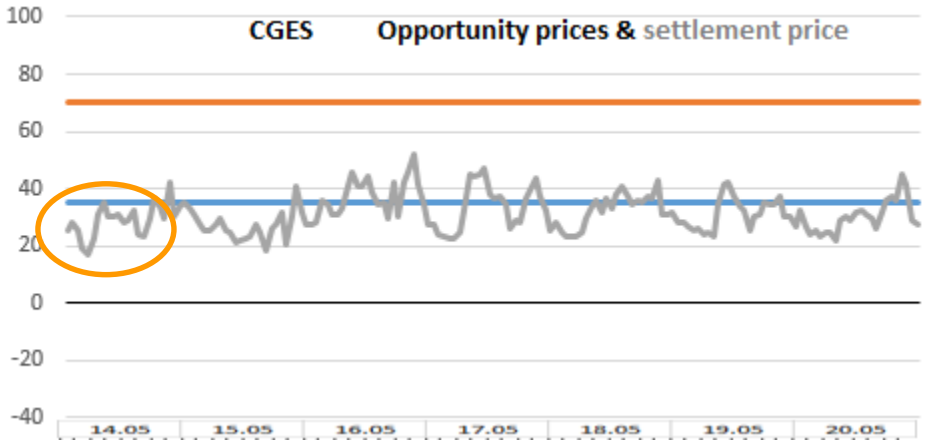
OST – Provided data for aFRR upward and downward

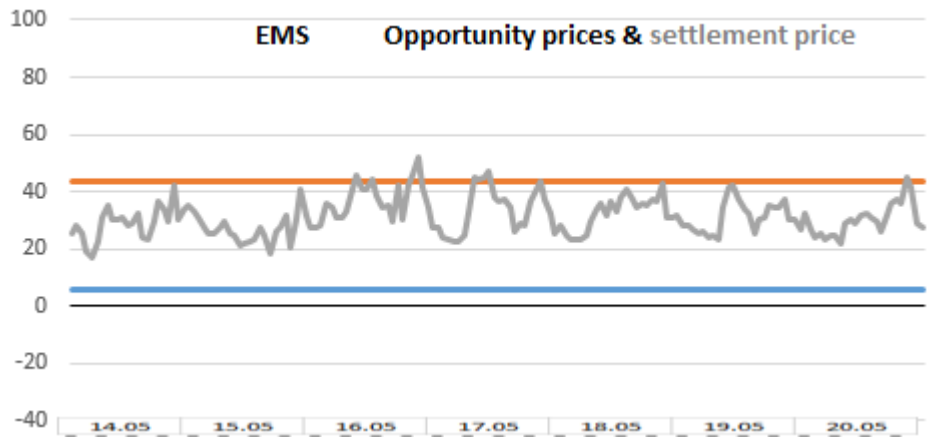
(1.5*HUPX and 0.05*HUPX

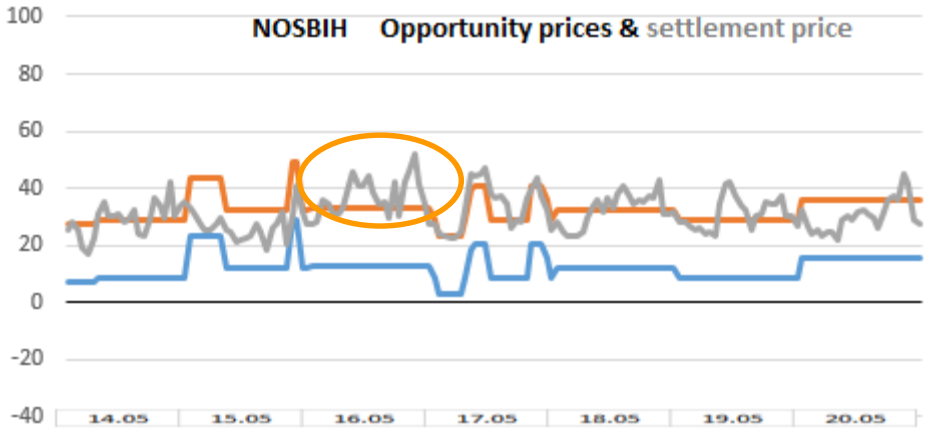
KOSTT – Assumed data for aFRR upward and downward (1.5*HUPX and 0.05*HUPX)

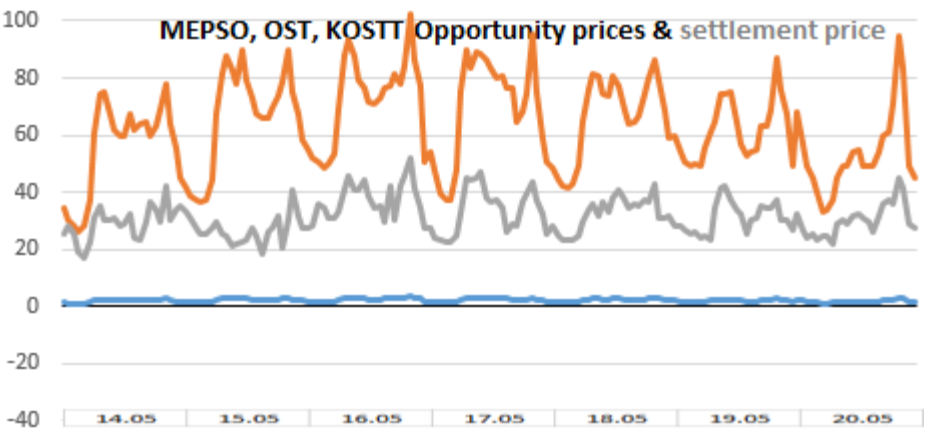
Opp. prices, settlement price

Opp. price, upward
Settlement price (WB6 test)
Opp. price, downward









Settlement price, as the result from "WB6 test" is shown as well

Perfect condition for max. savings is: Opp. Price, up > Settlement price > Opp. Price down

But, savings ensured for all TSOs even if it is not so in each timestamp

IN: Used data (Limits)

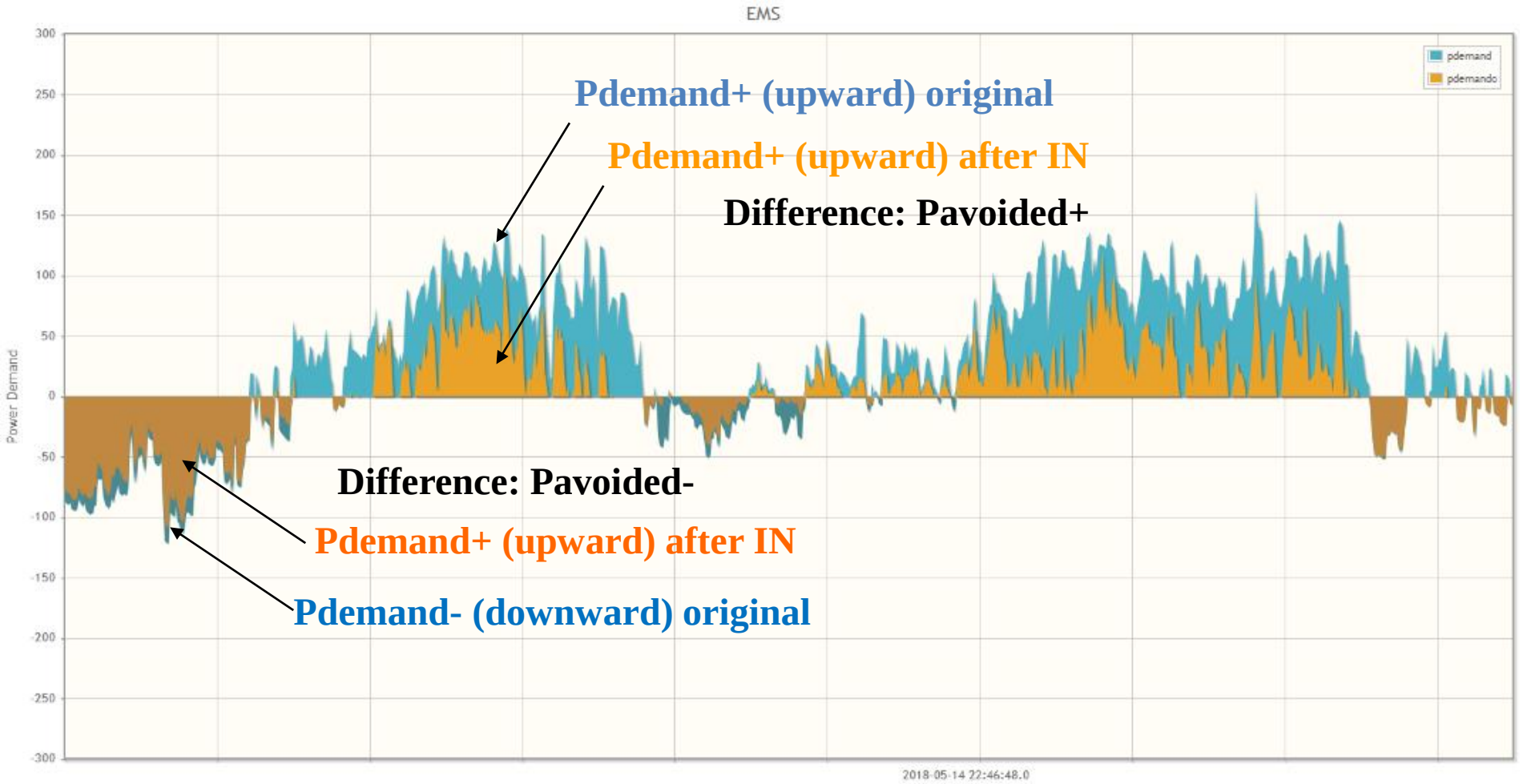
aFRR Limits: 200 MW per each TSO

ATC: Remaining ATCs after latest allocation (after day-ahead/Intraday) are used

Relatively high values: no congestions appear

from_Bidding Zone	to_Bidding Zone	ATC average
CGES	EMS&KOSTT	431
CGES	NOSBIH	295
CGES	OST	400
EMS&KOSTT	CGES	554
EMS&KOSTT	MEPSO	187
EMS&KOSTT	NOSBIH	541
EMS&KOSTT	OST	210
MEPSO	EMS&KOSTT	763
NOSBIH	CGES	705
NOSBIH	EMS&KOSTT	459
OST	CGES	103
OST	EMS&KOSTT	100

Analyses



Screenshot from online IN platform

http:/147.91.50.48:8181/CbEB

Comparison of MW outcomes

WB6 Summary (6 days)

	Upward				Downward			
	Pdemand+ sum	Pavoided+ sum	**Pavoided+ average MW**	**%avoiding+**	Pdemand- sum	Pavoided- sum	**Pavoided- average MW**	**%avoiding-**
EMS	3640	2003	**13.9**	**55%**	5585	1788	**12.4**	**32%**
CGES	445	308	**2.1**	**69%**	1853	870	**6.0**	**47%**
MEPSO	1019	736	**5.1**	**72%**	3448	1511	**10.5**	**44%**
KOSTT	1972	1355	**9.4**	**69%**	1439	527	**3.7**	**37%**
NOSBIH	1110	820	**5.7**	**74%**	1753	862	**6.0**	**49%**
OST	1053	743	**5.2**	**71%**	846	407	**2.8**	**48%**
		average	6.9	68%			6.9	43%

WB5 Summary (6 days)

	Upward				Downward			
	Pdemand+ sum	Pavoided+ sum	**Pavoided+ average MW**	**%avoiding+**	Pdemand- sum	Pavoided- sum	**Pavoided- average MW**	**%avoiding-**
EMS	3640	1758	**12.2**	**48%**	5585	1557	**10.8**	**28%**
CGES	445	290	**2.0**	**65%**	1853	821	**5.7**	**44%**
MEPSO	1019	688	**4.8**	**67%**	3448	1455	**10.1**	**42%**
KOSTT	1972	1261	**8.8**	**64%**	1439	488	**3.4**	**34%**
NOSBIH								
OST	1053	712	**4.9**	**68%**	846	386	**2.7**	**46%**
		average	6.5	62%			6.5	39%

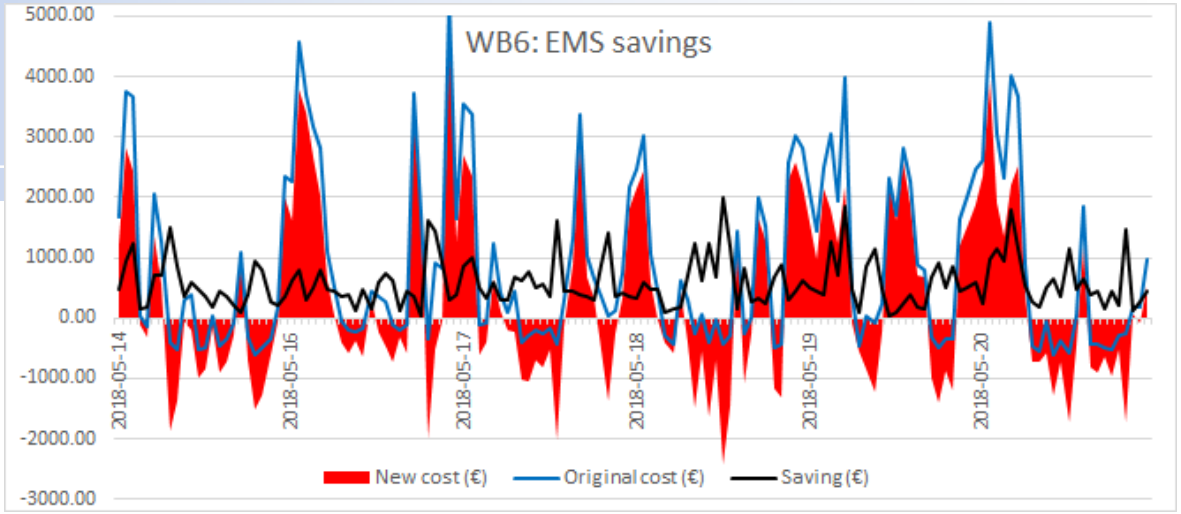
SMM Summary (6 days)

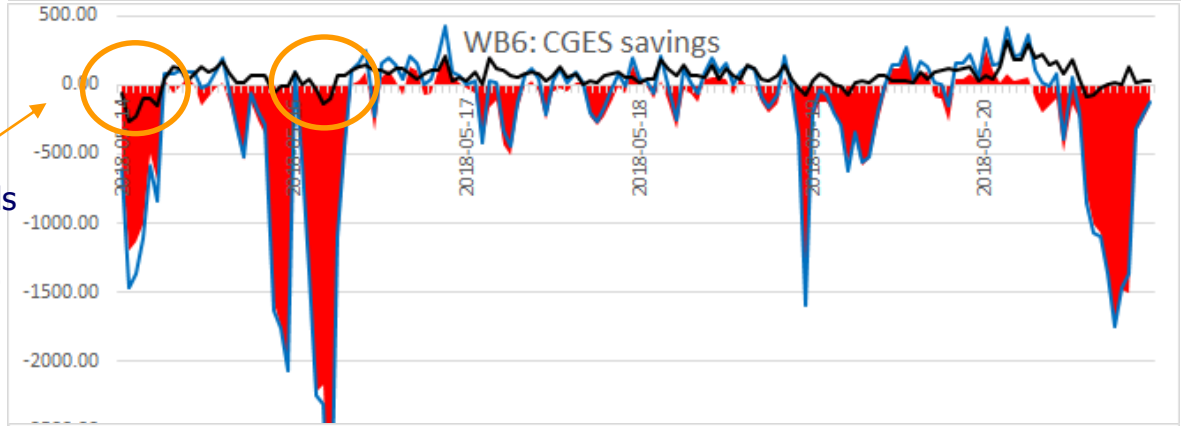
	Upward				Downward			
	Pdemand+ sum	Pavoided+ sum	**Pavoided+ average MW**	**%avoiding+**	Pdemand- sum	Pavoided- sum	**Pavoided- average MW**	**%avoiding-**
EMS	3640	1549	**10.8**	**43%**	5585	743	**5.2**	**13%**
CGES	445	286	**2.0**	**64%**	1853	669	**4.6**	**36%**
MEPSO	1019	696	**4.8**	**68%**	3448	1118	**7.8**	**32%**
KOSTT								
NOSBIH								
OST								
		average	5.9	58%			5.9	27%

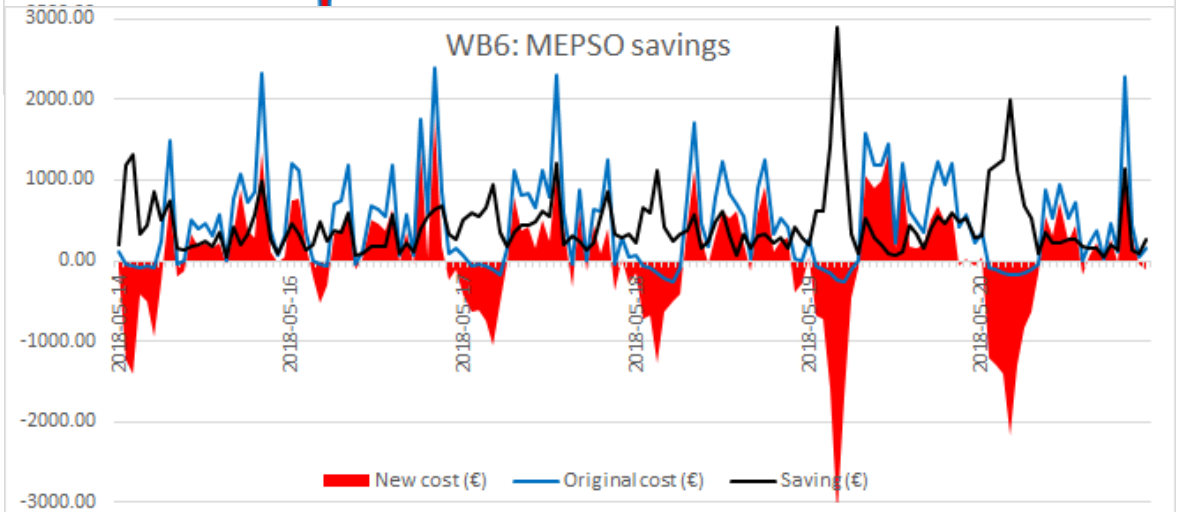
Savings: WB6 test

CGES: Down price is 35 EUR/MW, quite high.
⇒
"Beats" settlement price in some periods
⇒
Savings negative (loss) in some periods

But overall IN effect on MNE is benefit, as for all TSOs







Savings: WB6 test