19th June 2018

St. Paul - MN

Day Ahead and Real Time Operations -A European Point of View

ESIG - Market Operations Tutorial



Day Ahead and Real Time Operations - A European Point of View RENM

Topics:

- Internal Energy Market European Guidelines
- MIBEL Iberian Electric Market
- PCR Price Coupling of Regions
- XBID Cross-Border Intraday Market
- TERRE Trans European Replacement Reserves Exchange
- MARI Manually Activated Reserves Initiative
- IGCC Imbalance Netting
- PICASSO Platform for the International Coordination of the Automatic frequency restoration process and Stable System Operation
- RSC Regional Security Coordinators

Electricity

Transmission network



- 8.907 km of HV OHL and underground cables (400 kV, 220 kV e 150 kV)
- 67 Substations (37.382 MVA)
- 9 interconnections (6x400 kV + 3x220 kV)

Natural Gas

Transmission network + Terminal + Underground storage



- 1.375 km of pipelines (84 bar, 10¹¹ 32¹¹)
- 203 Stations (85 GRMS)
- 2 interconnections (1x 28'' + 1x20'')
- LNG Terminal in Sines
- 6 Underground Salt Cavities (4 TWh)

Internal Energy Market – European Guidelines





Internal Energy Market – Regional Markets



Regional Energy Markets: Iberian Market (MIBEL)

- Day-ahead Market
 - Iberian (PT+ES) offers
 - TSO validation of results
 - Considers forward and bilateral



Intraday Market

- 6 sessions
- 1st session: 27 hours ahead
- One session every 3 hours (in

average)

INTRADAY MARKET SESSIONS



Internal Energy Market – Regional Markets



Regional Energy Markets: Iberian Market (MIBEL)





Balancing the system

- RES curtailment versus import capacity reduction
 - For TSOs there is a tradeoff between maximizing capacities for the market and reducing the risk of RES curtailments.
 - We have in place a merit order to curtail RES
 - ✓ we have only curtail once!
- Increased reserves (deterministic formula)
 - Upward Reserves = Biggest Generator + 0,02 Load + 0,10 Wind
 - Downward Reserves = Biggest Pump + 0,02 Load + 0,10 Wind



Market Regional Coupling





PCR users and members







MRC – Multi-region Coupling 4MMC – 4M Market Coupling (Czech, Slovak, Hungarian, Romanian)

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European Internal Energy Market goal – Same price in every Mk area









Euphemia Algorithm

- EUPHEMIA stands for: EU + Pan-european Hybrid Electricity Market
 Integration Algorithm.
- EUPHEMIA is an algorithm that solves the market coupling problem on the PCR area.
- It maximizes the welfare of the solution:
 - Most competitive price will arise
 - Overall welfare increases
 - Efficient capacity allocation



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Price Coupling of Regions (PCR)

Market data

- Each PX (Market) operates
 several bidding areas.
- All bidding areas are matched at the same time.
- A different price can be obtained for each bidding area.
- The price for the bidding area must respect maximum and minimum price market boundaries.





XBID – Cross Border Intraday

Market



Cross-Border Intraday Market (XBID)



Objective: Establish a common crossborder **implicit continuous Intraday** solution across Europe, where all the cross border capacities are allocated.





Cross-Border Intraday Market (XBID)



Hybrid Model "A"



- 1. After each continuous intraday session, the TSO communicates the amount of interconnection capacity available to the XBID platform;
- 2. In this model, the market agents are able to bid for the intraday periods which are not available in the next session;
- 3. The central platform of XBID performs the process of matching of supply and demand bids continuously;
- 4. Transactions can be accepted up to 1 hour before the physical period of delivery.



High Level Go Live Planning: 13th June 2018



Cross-Border Intraday Market (XBID)



Detail of hourly trading in Model "A"



- 1. Model "B" is expected to be tested by NOV2018.
- 2. The difference between Models "A" and "B" is that in model "B" agents can bit for any subsequent market period (e.g. up to D+1).
- 3. In order to avoid double allocation of interconnection, during the Iberian intraday sessions, Xbid will be paused for a period not larger than 10 min.

Cross-Border Intraday Market (XBID)



Detail of hourly trading from 28/11/2018





Balancing



TSO-TSO balancing model



Power & Frequency control

- **Primary -> Frequency Containment Reserves (FCR)** 1.
- 2. Secondary -> Frequency <u>Restoration</u> Reserves (aFRR, mFRR)
- 3. Tertiary -> Reserve <u>Replacement</u> (RR)



TSO-TSO balancing model







TERRE - Trans European

Replacement Reserves Exchange



Trans European Replacement Reserves Exchange (TERRE)

TSOs Participants

TERRE members (6 TSOs)							
Rte							
national grid							
Terna							
RENM							
swissgrid							

Participants und not yet TERI	er the RR IF and RE members
Bulgaria	<u>الخ</u>
Hungary	MAVIR
Poland	<u> 25</u>
Romania	

TERRE O	bservers						
ADMIE	AAMHE						
Czech Republic	Čep s as						
Norway	Statnett						
ENTSO-E secretariat							
Potential interest (4 TSOs)							
Croatia	👭 HOPS						
Denmark	ENERGINET						
Finland	FINGRID						
Sweden							



Trans European Replacement Reserves Exchange (TERRE)

Operating mode





Trans European Replacement Reserves Exchange (TERRE)

TERRE timing of the different phases



Algorithm clearing resulting in counter-activations



Project schedule



November 2017



MARI - Manually Activated Reserves Initiative



Manually Activated Reserves Initiative (MARI)



TSOs Participants

Austria		Latvia	<u>/</u> 51					
BELGIUM	Celia	Lithuania	Litgrid					
CZECH REPUBLIC	čeps	Norway	Statnett					
Denmark	ENERGINET	NETHERLANDS	Tennet Taking power further					
ESTONIA	elering	Portugal	RENM					
FINLAND	FINGRID	POLAND	PSE					
FRANCE	Rte	Romania	Transelectrica®					
		SLOVENIA	ELES					
CEDMANN	Pamprion	Spain	RED ELÉCTRICA DE ESPAÑA					
GERMANY		Sweden						
	TR⊼NSNET BW	SWITZERLAND	<mark>swiss</mark> grid					
GREECE	AAMHE	United Kingdom	national grid					
ITALY	Terna Rete Italia							



TSOs in Process of
Becoming MembersHungaryMayirCroatiaMembers



Project Background

MARI project	Other/Previous Initiatives of the involved TSOs	Legal Background
 The goal is to create an European platform for mFRR New project independent from the existing initiatives TSOs of the cooperation started working on the principles of an mFRR platform already in 2016 5 April 2017 TSOs signed Memorandum of Understanding, which outlines the main design features of the project as well as the governance principles 	 Common Nordic mFRR market in operation Amprion/RTE – proposal for the design of an mFRR market DE/FR Explore – proposal for the design of an mFRR market AT/DE project for the implementation of an mFRR market mFRR discussions in the TERRE framework 	 Guideline on electricity balancing ("GLEB") Guideline on transmission system operation ("GLSO") Regulation 1222/2015, ("CACM") Regulation 1227/2011("REMIT") Regulation (EC) 714/2009

Manually Activated Reserves Initiative (MARI)



Similar process to that described for the TERRE - Trans European Replacement Reserves Exchange however the traded product has a shorter notice period:

- TERRE 30 minute notice;
- MARI Pre-notice less than 15 minutes (probably 12.5 minutes).

And in MARI there are two products:

- Schedule Activated The delivery of energy (start and end) is associated to the integration period of electric energy meters (equal to TERRE);
- Direct Activated The beginning of the energy delivery can occur at any time, that is, there is no association to the integration period of the electricity meters.

General process:



Manually Activated Reserves Initiative (MARI)

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Project schedule

• Proposal submission on European mFRR platform by 18-Dec-2018





Imbalance Netting

aFRR (TSO only)



Imbalance Netting



TSOs Participants



International Grid Control Cooperation (IGCC)

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The **IGCC** is a regional project operating the imbalance netting process which currently involves 11 TSOs from 8 countries.

These are the TSOs from AT (APG), BE (Elia), CH (Swissgrid), CZ (CEPS), DE (50Hertz, Amprion, TenneT DE, TransnetBW), DK (Energinet.dk), FR (RTE), NL (TenneT NL).







Monthly Volumes of Netted Imbalances



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Monthly Value of Netted Imbalances



International Grid Control Cooperation (IGCC)



Cumulated Value of Avoided Activations



International Grid Control Cooperation (IGCC)



Integration into the Secondary Control Loop



IGCC – Settlement Basic principle



Imbalance Netting





- 1. Every 4 seconds, the "deviation" of each control area is sent to the optimizer.
- 2. The optimizer, taking into account the interconnection capacities available between each system and the deviations of each control area, calculates corrections (interconnection flows) that are sent to the various systems in order to minimize the deviations that will be solved, individually, by each system.
- 3. Each local system receives an optimizer correction (part of its "deviation" that is resolved by the new flow in the interconnect). In this way, each system will mobilize less reserve of secondary regulation to cancel the "deviation".

Imbalance Netting



Project schedule – extension of the IGCC

			2018												2019											
Country	TSO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
Slovenia	ELES							,				()	111												I	
Croatia	HOPS																	L								
Hungary	MAVIR																									
Poland	PSE																									
Spain	REE																	: 1								
Portugal	REN			ļ														L								
Slovakia	SEPS			ļ														I.							I	
Romania	Transelectrica																									
Greece	Admie																									
Bulgaria	ESO																									
Italy	Terna																									
Serbia	EMS																								l	
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							\mathcal{U}		nte	erop	bera	abil	ity t	este	S (S(CADA	4.6)	S	8	Op	era	atio	nal	tes	ts (SCAE



PICASSO - Platform for the International Coordination of the **A**utomatic frequency restoration process and Stable System Operation

Physical and/or Financial Transmis sion Rights	Market Regional Coupling	XBID	TSO-TSO balancing model TERRE MARI
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aFRR (+Market)

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TSOs Participants

MEN	IBERS		OBSERVERS
Country	TSO	Country	TSO
Austria	APG	Bulgaria	ESO
Belgium	Elia	Croatia	HOPS
Czech Republic	ČEPS	Greece	ADMIE
Denmark	Energinet	Poland	PSE
Finland	FINGRID	Portugal	REN
France	RTE	Romania	TRANSELECTRICA
	TenneT GmbH	Slovakia	SEPS
0	TransetBW	Switzerland	SWISSGRID
Germany	50HERTZ		
	AMPRION		2
Hungary	MAVIR		
Norway	STATNETT		RE
Netherlands	TenneT BV		
Slovenia	ELES		
Spain	REE		
Sweden	SVENSKA KRAFTNÄT		







Scheme BRP – TSO <-> TSO – BSP model

BRP – Balancing Responsible Party (Energy Market)

BSP – Balancing Service Provider





General overview of bidding process





High level scheme of aFRR platform





Project schedule

- Proposal submission on European aFRR platform by 18-Dec-2018
- EGBL Electricity Balancing GuideLines





Regional Security

Coordinators





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RSCs are companies owned by their clients, the TSOs



Regional Security Coordinators



Core services performed by RSCs:

- 1. Operational planning security analysis; (DACF, 2DCF)
- 2. Outage planning coordination;
- 3. <u>Coordinated capacity allocation;</u>
- 4. Short- and very short-term <u>adequacy forecasts</u>;
- 5. Individual and common grid modelling and data set delivery.
 - ✓ Common Grid Model Exchange Specification (CGMES)

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Conclusion:

- Continuous markets allows a better integration of variable generation (wind & solar);
- System services is not a local market anymore; share reserves between each TSO, all over Europe, for every type of reserve: RR, mFRR and aFRR;
- RSC gives support to the TSO, avoiding duplicating tasks. The legal responsibility relies on the national TSO.



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