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Research Report

Empirics of Intraday and Real-time Markets in Europe: Italy

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Empirics of Intraday and Real-time Markets in Europe: ITALY

Report on behalf of DIW Berlin

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1. Introduction

The horizontal integration of the energy market and the organization of transmission services remain two open issues in the restructured European electricity sector. The creation of an efficient and flexible internal market for electricity, started with Directive 96/92/EC and Directive 2003/54/EC and further enhanced with the introduction of the Third Legislative Package (2009) and of the Network Codes, aims at creating a coordinated European electricity market that is able to guarantee competition among operators, to achieve the imposed environmental targets and to provide electricity companies with the right incentives to invest in new infrastructure so as to ensure security of supply.

The integration of the European day-ahead electricity markets has now become a reality thanks to the application of Market Coupling and the development of the Flow-Based Market Coupling approaches. However, despite these significant progresses, the harmonisation of intraday and balancing markets, as required by the European Target Model, has not yet been achieved. This ambitious objective is made more challenging by the increasing penetration of the intermittent generation technologies and by the different organizations of these markets in the European countries.

This paper aims at shedding some light on the functioning of the Italian electricity market and to describe the challenges that Italian operators are now facing in order to achieve the harmonization of the European wholesale market arrangements. In particular, this paper provides a detailed description of the current design of the Italian spot electricity market with a particular focus on intraday and balancing markets whose organizations are under discussion at European level.

The paper is structured as follows. In Section 2, we describe the functioning and the organization of the day-ahead, intraday and ancillary service markets. Section 3 illustrates how the Italian Transmission System Operator (TSO) conducts forecasts on load and intermittent renewable energy production as well as it operates congestion management. Section 4 is devoted to the analysis of imbalances, while Section 5 concentrates on reserve procurement. In Section 6, we summarize the main features of the current organization of the Italian electricity market and we describe some of the challenges that it is currently facing in order to accomplish with the requirements of the European Target Model. Finally, Section 7 concludes with some envisaged objectives and developments that the Italian Regulator intends to apply in order to increase the efficiency of the Italian electricity market.

2. Overview of the Italian spot electricity market

The Italian spot electricity market consists of three subsequent markets:

- 1) The day-ahead market (“Mercato del Giorno Prima” or “MGP”) where producers, wholesalers, and eligible final customers may sell/buy electricity for the next day (delivery day).
- 2) The intraday market (“Mercato Infragiornaliero” or “MI”) where producers, wholesalers, and eligible final customers may change the injection/withdrawal schedules determined in the day-ahead market. It replaces the former Adjustment Market that has been in force till the end of October 2009.
- 3) The ancillary service market (“Mercato del Servizio di Dispacciamento” or “MSD”), subdivided into MDS ex-ante and balancing market (“MB”). In the MSD, the Italian TSO, Terna S.p.A.¹, procures the ancillary services needed to manage, operate, monitor and control the power system. Through the MSD ex-ante, Terna mostly reliefs congestions and procures reserve margins; while in MB Terna accepts the same bids/offers mainly for balancing purposes.

The Italian Power Exchange, GME², is responsible for organising and managing the wholesale energy market, where electricity trading is aimed at scheduling generating and consuming units. More precisely, GME is responsible for the day-ahead (MGP) and the intraday electricity (MI) markets and acts as central counterpart of sale and purchasing transactions in these markets. Moreover, GME supports Terna over MSD ex-ante and MB (collection of the bids and communication of results to market parties) where the TSO procures ancillary services and balancing energy as described in Table 1.

	Energy Market (GME-PX)	Ancillary Services Market (Terna-TSO supported by GME) Balancing Market (Terna-TSO)
Structure	Day-ahead electricity market (MGP) Intraday market (MI)	Ancillary service market (MSD ex-ante) Balancing market (MB)
Goals	Dispatch of generation units Implicit allocation of cross zonal capacity Energy sell/purchase	Procurement of ancillary services and balancing energy
Delivery	Physical delivery	Physical delivery
Pricing Mechanism	Marginal price	Pay-as-bid
Geographical scope	Zonal	Nodal
Participation	Voluntary	Mandatory ³

Table 1: Information on the Italian spot electricity market (Source: Terna, 2013a)

¹ Terna S.p.A. See <http://www.terna.it/Default.aspx?tabid=101>

² Gestore Mercati Energetici (GME). See <http://www.mercatoelettrico.org/en/Default.aspx>

³ In this case, obligation is for generation facilities with technical capabilities to provide bids into MSD.

Intraday, MSD ex-ante and balancing markets are subdivided into a set of market sessions, namely a set of activities of receipt and processing of bids/offers as well as of determination of market results. As indicated in Tables 3, 4 and 5 of Sections 2.2 and 2.3, these sessions have different opening and closure gate times. In each session, bids/offers must be received within a given time interval. Depending on the considered market, sessions can take place either in day-ahead (D-1) or in delivery day (D). These are distributed as indicated in Table 2. Instead, day-ahead market is composed of one single session.

	Energy Market	Ancillary Services Market Balancing Market
Sessions	Day-ahead market (MGP): D-1 Intraday market (MI): D-1 and D	Ancillary service market (MSD ex-ante): D-1 and D Balancing market (MB): D

Table 2: Sessions of the Italian spot electricity market (Source: Terna 2013a)

2.1. Characteristics of the day-ahead electricity market (MGP)

The Italian day-ahead electricity market (MGP) is a wholesale electricity market, where hourly blocks of electricity are negotiated for each of the twenty-four hours of the next day (delivery day). The Italian MGP is a physical market where not only prices and volumes, but also injection and withdrawal schedules are defined for each hour of the next day.⁴ The participation to the day-ahead electricity market is voluntary and open to all agents pre-qualified to operate on the GME platform (see GME, 2012).

The Italian day-ahead market is based on a market splitting system (implicit auction model) subdivided into several bidding zones.⁵ It hosts the spot transactions of purchase and sale of electricity and also accounts for OTC contracts (through the so-called “PCE”).⁶ This solution takes into account all trades with physical delivery and is implemented for efficient congestion management purposes.

The zonal configuration depends on how Terna manages the flows along the Peninsula, taking into account structural transmission constraints. After the launch of the Italian Borders Market Coupling on the 24th of February 2015 and with the inauguration of the new submarine power cable

⁴ For futures, see Italian Derivates Energy Exchange (IDEX) at <http://www.lseg.com/areas-expertise/our-markets/borsa-italiana/derivatives-markets/idx>

⁵ The power system is divided into portions of transmission grids (zones) where, for purposes of power system security, there exist physical transmission limits for transferring electricity to/from the corresponding neighbouring zones. These transmission limits, also defined as structural congestions, are determined through a computational model that is based on the balance between electricity generation and consumption according to general criteria defined by the Italian Regulatory Authority for Electricity Gas and Water (AEEGSI).

⁶ The term “PCE” stands for “Piattaforma Conti Energia a Termine”. The schedules of electricity traded with OTC contracts and registered onto the PCE are submitted to the MGP in the form of bids/offers and contribute to determine the results of the MGP. These bids/offers participate to the market splitting process since their volumes commit a share of the transmission capacity available for flows and are also used to define the single purchase price (PUN) paid by buyers (see GME, 2009).

interconnecting Sicily with Malta on the 9th of April 2015, the current zonal configuration of the Italian electricity market accounts for:

- 6 geographical zones (Northern Italy, Central-Northern Italy, Central-Southern Italy, Southern Italy, Sicily and Sardinia);
- 11 neighbouring countries' virtual zones (France, XFRA, Switzerland, Austria, XAUS, Slovenia, BSP, Corsica, Corsica AC, Greece and Malta);
- 5 national virtual zones (Monfalcone, Rossano, Foggia, Brindisi and Priolo) representing constrained zones, consisting only of generating units, whose interconnection capacity with the grid is lower than their installed capacity.

After the successful coupling with France, Austria and Slovenia, two additional neighbouring countries' virtual zones have been included in the zonal representation. These are denoted as "XFRA" and "XAUS" and respectively represent the interconnections devoted to market coupling with France and Austria. The neighbouring country's virtual zone "BSP" indicates the interconnection dedicated to market coupling between Italy and Slovenia.⁷

The application of the market splitting mechanism clears the day-ahead market and defines the equilibrium prices and volumes. In this mechanism, the algorithm implemented by the GME gives as a result the application of two different pricing systems that depend on market operators. More precisely, producers, imports (virtual producers) and exports (virtual consumers) located in neighbouring countries' virtual zones are remunerated at zonal prices, while all buyers located in any of the national geographical zones are remunerated at a single purchase price (PUN, or system price).⁸ The PUN comes from an iterative computation of bids and offers embedded into the algorithm and represents the average of zonal selling prices weighted for zonal consumption.⁹

Since the 10th of February 2015,¹⁰ the gate opening time of the day-ahead electricity market is set at 8:00 of the ninth day before the day of delivery (D-9) and the gate closure time is at 12:00 of the day

⁷ Note that the coupling of the Italian-Slovenian border has been in force since the 1st of January 2011.

⁸ As also indicated in the description of the functioning of the Euphemia algorithm, in order to comply with the acceptance rules of the buyers' bids, the PUN is not computed after the clearing of the day-ahead market, but it is defined simultaneously to the computation of the zonal selling prices paid by producers. See <https://www.mercatoelettrico.org/it/MenuBiblioteca/Documenti/20140704EuphemiaPublicDocumentation.pdf>

⁹ Note that PUN and zonal selling prices are used to define the value of the physical transmission rights that are implicitly assigned to market participants. The value of these physical transmission rights (PTRs), named CCTs ("Corrispettivi per l'assegnazione dei diritti di utilizzo della capacità di trasporto"), is defined on hourly basis and corresponds to the difference between PUN and the zonal price. CCTs are implicitly collected through day-ahead auctions, while the selling operators involved in the OTC contracts directly pay or receive them, according to the difference between PUN and zonal prices. The risk of volatility of CCTs pertaining to national transits can be hedged with financial contracts (FTRs), the so-called CCCs ("Coperture rispetto ai costi di congestione") that are signed between Terna and the interested Balancing Responsible Parties (see Section 4). CCCs allow market players to substitute uncertain costs/revenues, namely CCTs, with certain costs/revenues.

¹⁰ The "Price Coupling" mechanism, indicated by the Capacity Allocation and Congestion Management (CACM) as the Target Model to be applied in order to reach the integration of the European electricity markets, imposes a unique gate closure time for all spot day-ahead electricity markets. This gate closure time has been set at 12:00 a.m. Since the closure gate time of the Italian day-ahead market was set at 09:15 a.m., a modification and the consequent re-organization of the intraday and the ancillary service markets have been necessary. These changes entered into force on February 10, 2015 (energy flows on February 11, 2015) before

before the delivery day (D-1). GME publishes preliminary information¹¹ about the day-ahead market on its website by 11:30 of the (D-1) day. GME publishes the provisional market results, notifies the individual market results to participants and the cumulated schedules to dispatching users and to Terna by 12:55 of the (D-1) day. Moreover, the recording of bilateral transactions through the dedicated platform (PCE) managed by GME may be affected at any time, provided that the transactions relating to delivery day (D) will be recorded from the day D-60 up to 10.00 of the D-1 day.

2.2. Characteristics of the intraday market (MI)

Once the day-ahead market is cleared, agents can **adjust their schedules** through the intraday market (MI), also taking into account information updates (e.g. weather forecast), unplanned events (e.g. outages) and fine-tuning of consumption requirements forecasts. MI enables participants to change their injection/withdrawal schedules determined in the day-ahead market, as well as their commercial positions. This market becomes a relevant optimization function especially for those generation facilities, which might present dynamic constraints one hour to the other.

The Italian intraday market has been conceived as a protraction of the day-ahead electricity market and is managed with the same rules applied for the MPG. Similarly to MGP, the intraday market is organized in the form of implicit auctions and accounts for the same zonal representation adopted in the day-ahead market.¹² The participation to MI is voluntary and open to all agents pre-qualified to operate on the GME platform. In addition, as for the day-ahead market, MI does not account for complex bids so far. Benefits of the organization of the Italian MI as an implicit auction system, which opposes to the continuous trading model, are: coherent design through time frames, transparency in prices, a level playing field for all market players, pooling of resources and pricing of cross-zonal capacity.¹³

Since the 11th of February 2015, this market is subdivided into five auction sessions, with different closing time and organized in sequence. This organization of the intraday market approximates the

the launch of Italian Borders Market Coupling (IBWT project) with France, Austria, and Slovenia fixed on February 24, 2015.

¹¹ Before the MGP, GME provides market participants with information on the expected electricity requirements for each hour and each zone and the maximum admissible transmission limits between neighbouring zones for each hour and each pair of zones. For each hour and each zone, GME also specifies the conventional reference price, i.e. the price that GME conventionally applies to demand bids without a price limit.

¹² While this is possible before day-ahead, in intraday there is no possibility to adjust schedules through bilateral contracts, in order to allow efficient congestion management taking into account time constraints (very limited time to run explicit auctions for capacity).

¹³ In particular, in an auction-based process, each agent submits its bid/offers and enters a price that corresponds to its willingness to be paid/to pay. On the contrary, in a continuous process, the price sent by agents can be strongly affected by the prices that are already in the order book. In addition, the auction-based process allows for an implicit cross-zonal capacity pricing that, instead, is not guaranteed in the current organization of continuous markets where capacity is allocated on the basis of the first-come and the first-served (FCFS) principle. The main consequence of the application of this principle is that capacity is offered for free till it is fully used and the willingness to pay for it is not reflected in a capacity price. This may result in a capacity allocation that is not optimal and does not lead to a welfare optimization process.

frequency of continuous trading. These five sessions are respectively denoted as MI1, MI2, MI3, MI4 and MI5.¹⁴ The first two (MI1 and MI2) intraday sessions are held one day ahead (D-1) the effective delivery of electricity immediately after the closure of the day-ahead electricity session; while the other three (MI3, MI4 and MI5) intraday sessions are held on delivery day (D). Through these auctions, participants can modify the injection and withdrawal schedules resulting from the day-ahead electricity market or other MI preceding sessions, taking into account more up-to-date information about the status of their own power plants, the electricity requirements for the next day and market conditions.

As in the day-ahead electricity market, GME accepts bids/offers submitted into the intraday market under the merit order criterion, taking into account the updated transmission limits. The accepted bids/offers modify the preliminary schedules and determine the updated flows and injection and withdrawal schedules of each offer point¹⁵ for the next day. If there are other market sessions after the one to which these updated GME's results refer, these results are required by Terna to determine preliminary information about residual transmission capacities between zones for subsequent market sessions. Table 3 provides information about the gate opening and closure times, the trading hours, and the communications of each of the MI sessions. Note that participation in the MI is voluntary.

	MI1	MI2	MI3	MI4	MI5
Preliminary information	15:00 (D-1)	16:30 (D-1)	3:45 (D)	7:45 (D)	11:30 (D)
Gate opening time	12:55 (D-1)	12:55 (D-1)	17:30 (D-1)	17:30 (D-1)	17:30 (D-1)
Gate closure time	15:00 (D-1)	16:30 (D-1)	3:45 (D)	7:45 (D)	11:30 (D)
Trading hours	1-24 (D)	1-24 (D)	8-24 (D)	12-24 (D)	16-24 (D)
Definitive results	15:30 (D-1)	17:00 (D-1)	4:15 (D)	8:15 (D)	12:00 (D)

Table 3: Timing of the Italian intraday sessions (Source: GME, 2014a; 2015)

Unlike in the day-ahead electricity market, the PUN is not calculated in the intraday market and accepted bids/offers are all remunerated at the zonal clearing price (see GME, 2012). However, in order to replicate the effect of the application of the PUN to buyers (representing consumers) located in the Italian geographical zones and to avoid biased arbitrage opportunities, GME applies a non-arbitrage fee to all accepted bids/offers pertaining to such points.¹⁶

One faces different situations depending on the considered transaction as indicated in the following:

¹⁴ Before the 10th of February 2015, the intraday market was subdivided in four sessions (MI1, MI2, MI3, MI4): the first two were organized one day ahead (D-1) the effective delivery of electricity; the other two were held on delivery day (D).

¹⁵ Each geographical or virtual zone is a set of offer points. Offer points are the minimum units of electricity for which hourly injection and withdrawal schedules must be defined (pool and OTC). In the case of injection schedules, the injection offer points are usually individual generating units. Conversely, in the case of withdrawal schedules, the withdrawal offer points may correspond both to individual points of withdrawal, i.e. individual consuming units, and to sets of withdrawal points.

¹⁶ The MI has been designed as a purely adjustment market where agents operate in order to update or modify their schedules defined in MGP. Consumers face the PUN and the zonal prices respectively in MGP and MI. The non-arbitrage fee is imposed in order to induce consumers to participate to the MI only if they have to really change their schedules and not to take advantage of the price differences between PUN and zonal prices.

- **Purchase transaction** concluded in the MI by a withdrawal point: if the PUN price set in the day-ahead market is higher (*lower*) than the MI zonal price, the market participant will pay (*receive*) a non-arbitrage fee that is equal to the difference between the PUN and the zonal price, applied to each MWh covered by the purchase transaction.
- **Sale transaction** concluded in the MI by a withdrawal point: if the PUN price set in the day-ahead market is lower (*higher*) than the related zonal price, the market participant will pay (*receive*) a non-arbitrage fee that is equal to the difference between the zonal price and the PUN, applied to each MWh covered by the sale transaction.

Figure 1 shows the total electricity volume exchanged on the Italian intraday market till 2013.¹⁷

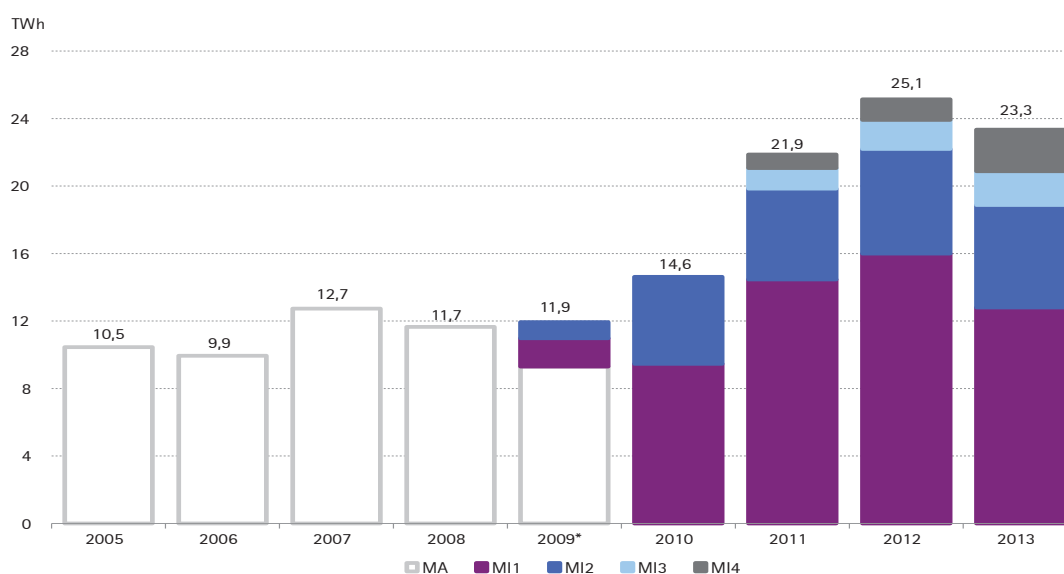


Figure 1: Volume exchanged on the Italian intraday market (2009-2013) and on the former adjustment market (2005-2009) in TWh (Source: GME, 2014b)

The liquidity of the intraday market is a key element that be used to measure the well functioning of the market and the efficiency of cross-border intraday trading. Figure 2 shows the liquidity levels of the European intraday markets in 2013, expressed as traded volumes. The characteristics of the Italian MI, which is an auction-based market where agents can adjust their schedules closer to real time, make it more liquid than the majority of the European intraday markets as indicated in Figure 2.

¹⁷As already indicated, the subdivision of intraday market into five sections entered in force on February 2015. Recall that the current intraday market replaced the former adjustment market (MA) in 2009. More precisely, MI1 and MI2 became operational on the 31st of October 2009, while MI3 and MI4 were introduced on the 1st of January 2011.

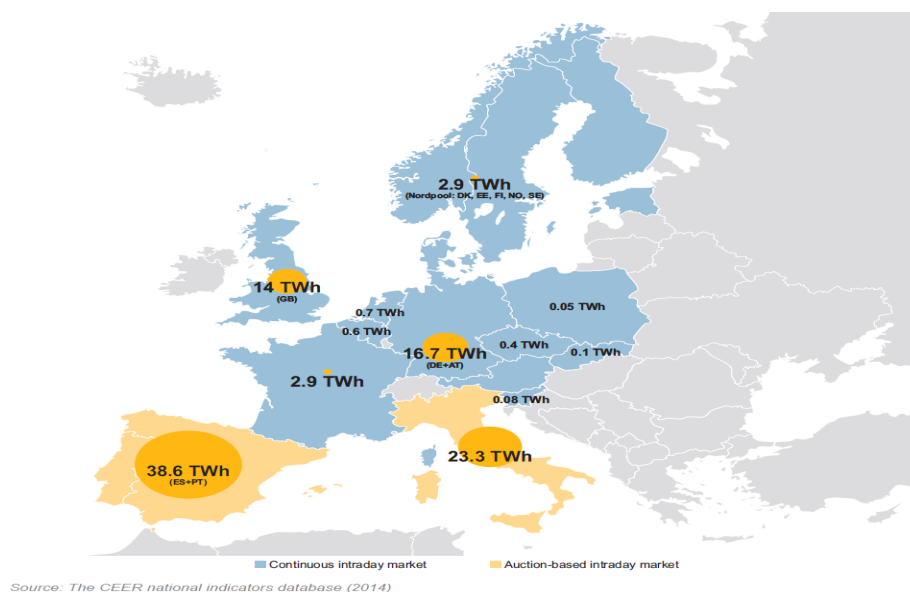


Figure 2: Volume exchanged on the European intraday markets in 2013 in TWh (Source: ACER/CEER, 2014)

2.3. Characteristics of the ancillary services market (MSD): MSD ex-ante and balancing market (MB)

Day-ahead and intraday markets count on a simplified representation of the network, namely the zonal design. Therefore once any day-ahead and intraday market section is cleared, Terna, in charge at national level for system operation, assesses system constraints on nodal basis and procures, through MSD, ancillary services (e.g. reserve margins and re-dispatching actions) and balancing energy to ensure reliable and efficient real-time power system functioning.

For the sake of clarity, we specify that MGP, MI and MSD represent subsequent markets. This approach allows procurement of ancillary services once wholesale markets are already cleared, at a very short notice, and with a clear forecast of the system state, which, in turns, guarantees higher efficiency and reliability. It is worth noting that Terna, even if it is allowed to do so, does not procure any long-term service and does not undersign any bilateral contract with service providers. Thus, MSD allows for pooling and co-optimisation of resources and, at the same time, guarantees transparency in terms of prices and scarcity values to appear.

The approach adopted in Italy takes inspiration from the US markets and ISO models and attributes to Terna, the Italian TSO, a central and proactive role as the real-time approaches. The operational functions of Terna are organized through the market. In particular, Terna operates the Italian power system according to the Central Dispatch System approach, where the Italian TSO determines the commitment and output of a majority of generation or demand and issues dispatch instructions directly to them. These instructions partially start in the day-ahead and intraday timeframes (physical markets), but the core is done through the ancillary services market, mainly in the MSD ex-ante (D-1) and sometimes in real time (D). Only after the clearing of the day-ahead and intraday markets, the TSO runs the ancillary service market (MSD ex-ante) to ensure system reliability on nodal basis, especially procurement of reserve margins and re-dispatch actions.

The model counts on a centralised function to dispatch the system on a nodal basis. Through MSD, Terna procures reserve margins, re-dispatching actions and balancing energy together with other local needs as reactive power and voltage support. In doing that, Terna accounts for a more realistic nodal representation of the network and considers all the security constraints of the system and, to some extent, technical constraints of generation units.

MSD ex-ante functions in a corrective logic from the day-ahead and intraday market schedules (up and downward offers) as in these latter cases no security constraints are applied with the important exception of cross-zonal capacity limitations.

In the MSD ex-ante, Terna enters into purchase and sale transactions in order to obtain resources for its dispatching service and acts as single counterparty of the transactions.

Bids/offers must refer to offer points authorised to provide ancillary services in the MSD and these have to be submitted by the respective service providers directly (without agents acting on their behalf). Bids are selected as the output of an optimization algorithm on nodal basis run by the TSO taking into account complex bids (fix, start-up and variable costs). This is a co-optimized process dealing with re-dispatch, reserve procurement, balancing energy and taking into account also system constraints as boundary conditions. Note that, for each demand bid accepted in the MSD and pertaining to withdrawal points, GME determines the non-arbitrage fee that the participant has to pay, if negative, or receives, if positive. The approach used to compute this non-arbitrage fee is equivalent to that used in the MI.¹⁸ All accepted bids/offers are remunerated at the offered price according to the pay-as-bid methodology.

Since the 11th of February 2015, MSD ex-ante consists of four scheduling sessions: MSD1, MSD2, MSD3, and MSD4 that are organized as indicated in Table 4.¹⁹

	MSD1 (D-1)	MSD2 (D)	MSD3 (D)	MSD4 (D)
Gate opening time	12:55 (D-1)	Bids/offers MSD1	Bids/offers MSD1	Bids/offers MSD1
Gate closure time	17:30 (D-1)			
Trading hours	1-24 (D)	8-24 (D)	12-24 (D)	16-24 (D)
Definitive results	21:10 (D-1)	6:15 (D)	10:15 (D)	14:15 (D)

Table 4: Timing of the Italian MDS ex-ante sessions (Source: GME, 2014a; 2015)

As shown in Table 4, bids/offers can be submitted and selected in the MSD1 only. This session opens at 12:55 of the day before (D-1) the delivery day and closes at 17:30 of (D-1). The results of the MSD1 are made known by 21:10 of the day before (D-1) the delivery day (D). In accordance with the national network code, GME provides participants with the individual results (bids/offers accepted by Terna) of the session of the MSD2 within 6:15 of the delivery day. MDS3 and MDS4 are organized in a

¹⁸ Note that the application of the non-arbitrage fee for withdrawals points is foreseen in MSD, but it is not applied in practise since withdrawal points do not participate to MSD because of the lack of adequate requirements.

¹⁹ Before the 11th of February 2015, MDS ex-ante was subdivided in three sessions (MSD1, MSD2, MSD3). As in the current organization MSD1 was organized in (D-1); while MSD2, MSD3 were held on delivery day (D). The former MSD2 and MSD3 sessions correspond to current MSD3 and MSD4 sessions.

similar way. In these markets, individual results are notified by GME respectively at 10:15 and 14:15 of the delivery day (D).

The MB takes place in real-time and it is subdivided into 5 different sessions as indicated in Table 5.²⁰

	MB1 (D)	MB2 (D)	MB3 (D)	MB4 (D)	MB5 (D)
Gate opening time	Bids/offers MSD1	22:30 (D-1)	22:30 (D-1)	22:30 (D-1)	22:30 (D-1)
Gate closure time		7:00 (D)	11:00 (D)	15:00 (D)	21:00 (D)
Trading hours	0-8 (D)	8-12 (D)	12-16 (D)	16-22 (D)	22-24 (D)

Table 5: Timing of the Italian balancing market (MB) sessions (Source: GME, 2014a; 2015)

The MB1 takes into consideration the valid bid/offers that participants have submitted in MSD1. The other MB sessions open at 22:30 of the day before delivery (D-1) and all close in real-time (D) one hour before the first hour that may be negotiated in each session. In the MB, Terna accepts energy offers in order to activate secondary control and to balance energy injections and withdrawals into/from the grid in real time.

Moreover, for each of the five MB sessions, GME publishes market results of each accepted bid/offer and notifies participants within the fifteenth day of the month M+2. This lag takes into account the time needed for DSOs and the TSO to access to metering data and perform all the procedures according to the settlement rules as defined by AEEGSI, the Italian National Regulatory Authority (NRA), and specified into the national network code.²¹

All in all, the timeline of the Italian electricity market is as illustrated in Figure 3.

²⁰ Differently from the MI and MSD ex-ante markets where the number of the sessions has been increased as a consequence of the modification of the MGP gate closure time, the number of MB sessions has not been subject to any changes.

²¹ The national network code is only available in Italian at http://www.terna.it/default/Home/SISTEMA_ELETRICO/codice_rete.aspx

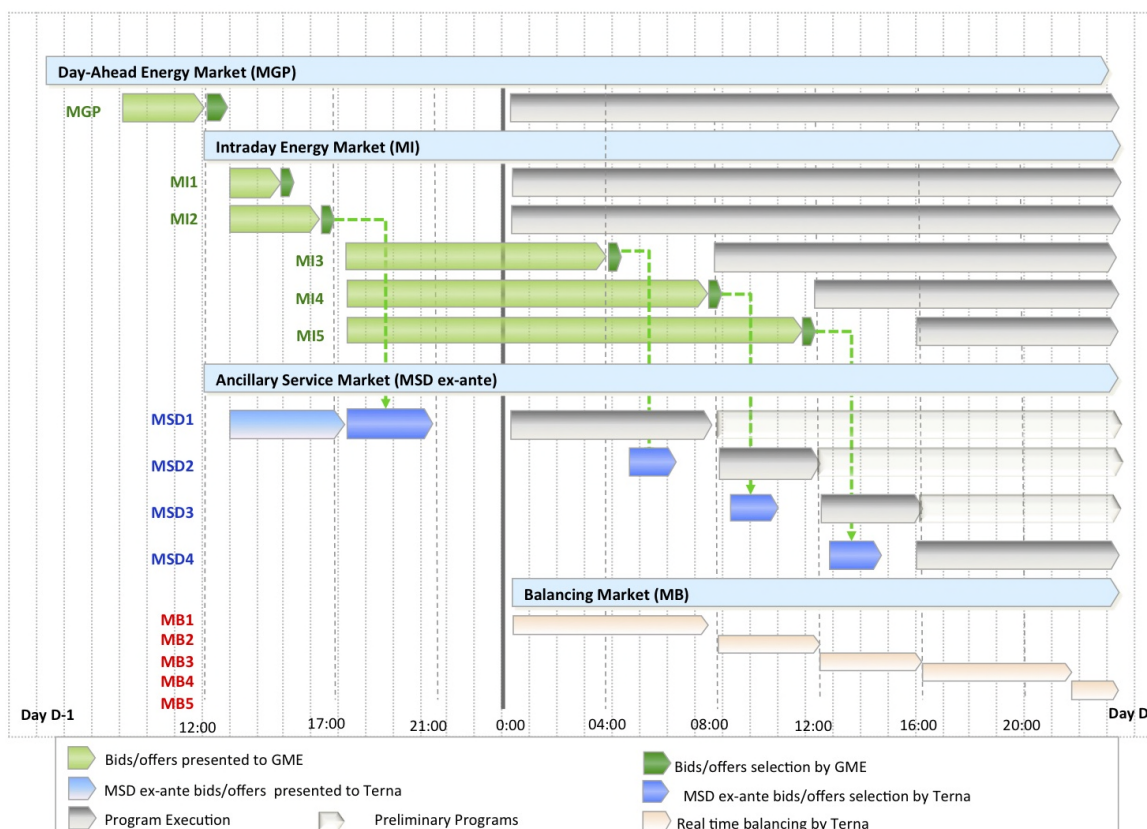
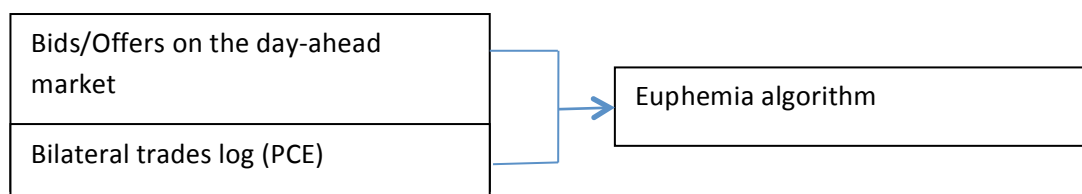


Figure 3: Timeline of the Italian electricity market

3. System forecasts and congestion management

As mentioned above, the Italian Power Exchange (GME) acts as a service provider to the Italian Transmission System Operator (Terna). In particular, GME manages the clearing of the day-ahead and intraday markets, organized in the form of a pool (implicit auctions). Obligations are in place as for all physical transactions to pass through the pool by considering both bids/offers presented during the auctions and bilateral trades as inputs to the algorithm.



This approach is in place in order to perform efficient congestion management. The TSO is informed of the unit specific schedule as far as the results of the day-ahead or intraday markets are available (see Sections 2.1 and 2.2).

The pool is organized on a unit-based principle for generation units with a nominal power above 10 MVA and the results of the clearing of the day-ahead and intraday markets are, at the same time, valid for the nominations of those generation units to the TSO as well. Smaller generation units and load are scheduled at zonal level. Their zonal aggregation is explained in Section 4.

Based on the results of the day-ahead and intraday markets, the ancillary service market (MSD), including the balancing market, is set. At this stage, Terna procures reserve, re-dispatch generation units to solve intra-zonal congestions and procure balancing energy through a single optimized process. More precisely, in the MSD ex-ante, Terna accepts offers with the aim of minimizing procurement costs of the dispatched resources. In doing that, Terna takes into account some technical constraints represented by:

1. Balancing between injections and withdrawals;
2. Congestions resolution;
3. Satisfaction of reserve requirements;
4. Other local constraints.

Considering the first constraints, Terna runs its own forecasts for load and intermittent renewable energy production. The balancing between injections and withdrawals is also influenced by the difference between forecasted load and load levels resulting from the day-ahead and intraday markets, as well as by the difference between the forecasted energy production from renewables and the production levels resulting from the day-ahead and intraday markets.

Note that forecasts for load and intermittent renewables energy production are first conducted before the clearing of the day-ahead electricity market. They are then updated in the MSD ex-ante. Load and intermittent renewable energy production forecasts are defined on hourly basis taking into account the market zonal subdivision. Load forecast represents the electricity demand in a geographical zone and refers to the hourly period immediately before the considered hour.²² This forecast includes grid losses and is netted by the amount of electricity consumed in the pumping phase of the pumped-storage hydro plants and by the quantity of electricity produced for self-consumption. Terna carries out load forecasts on the basis of the most updated information available on consumption trend and weather conditions of the considered day. Forecasts of the intermittent renewable energy production are based on the analysis of weather conditions (see Terna, 2014).

As far as congestion management is concerned, Terna identifies short-term intra-zonal congestions once results and the information of the day-ahead and intraday markets are available. On the longer term, the TSO estimates the structural congestions in order to split the transmission network into bidding zones and allocate FTRs. We recall that, since February 2011, Terna participates to Coreso²³ that provides the control centres of participating TSOs with forecasts about the security of transmission systems and coordinates exchanges between the national control centres, which are in charge of implementing these actions in their respective systems (see Coreso, 2014). Italy together with France, Germany, Austria, Slovenia and Greece belongs to the Central Southern Europe (CSE) area (Switzerland participates as well). Taking into account its experience in the Central Western Europe (CWE) region, Coreso is now involved into the development of the two-day-ahead capacity

²² For instance, the electricity demand at hour 1 refers to the hourly period from 0:00:00 to 0:59:59.

²³ See <http://www.coreso.eu/>

calculation project for the CSE area. Every day, Coreso will merge the best two-day-ahead forecasts for RTE, Terna, Swissgrid, Eles and APG and optimise the import capacity for the Northern Italian border. As a Central Entity (on behalf of RTE and Terna) and in cooperation with Swissgrid, Eles and APG, Coreso will be in charge of performing quality checks, merging of the Two-Days Ahead Congestion Forecast (D2CF)²⁴ and Day-Ahead Congestion Forecast (DACF)²⁵ files respectively provided by each TSO and automatically calculating maximum import Net Transfer Capacities at the Northern Italian border.

4. Balancing responsible parties and imbalances

In the Italian electricity market, generation and load are always considered separate Balancing Responsible Parties (BRPs).

Any generation unit with nominal power above 10 MVA is responsible for its own position. For example, two different CCGT plants (with nominal power above 10 MVA each) in the bidding zone “Northern Italy” and belonging to a same company are considered as separate units with separate positions. According to their technical capabilities (see Section 5 for the qualification requirements), a subset of these units is denoted as “qualified units”, or in other terms as Balancing Service Providers (BSPs). Currently, the dispatching units that correspond to the qualified units are remunerated pay-as-bids. Qualified units must participate to the ancillary service market (MSD).

Generation units with nominal power smaller than 10 MVA and belonging to the same company are, in general, aggregated at zonal level. The same applies to load units supplied by each company. According to the provisions set into the national network code, these generation and load units are denoted as “not-qualified units”, i.e. they are not considered BSPs, and cannot participate to the ancillary service market since they don’t have adequate technical capabilities (see Terna, 2015).

Considering the rules currently applied, the mechanism for calculating the imbalance volumes and prices as well as the Imbalance Settlement Period (ISP) depend on the considered category (qualified and non-qualified units).

The imbalance volumes of the qualified units are calculated as the difference (up or down) between the hourly schedule they submit (through GME) and the physical injection (measured by metering) on a 15 minutes basis. Hourly bids are converted into 15 minutes steps through a profiling technique set into the national network code. These qualified units face a dual pricing system for imbalances and their ISP is 15 minutes.

Schedules, metering, imbalance volumes (up or down) and ISP for not-qualified units are set on hourly basis. Households smaller than 55kW are usually profiled and their positions are adjusted once metering data are available (usually twice a year). Their imbalances are treated with a single pricing system.

²⁴ See <http://www.coreso.eu/activities/2-days-ahead/>

²⁵ See <http://www.coreso.eu/activities/day-ahead/>

The different pricing mechanisms applied for imbalances of qualified and not-qualified units reflect the different roles played by these two groups of units in the balancing market. Qualified units are the unique service providers on the balancing market and thus Terna relies on them to guarantee the security of the whole system. The underlying logic of the application of a dual pricing system to qualified units consists in dissuading these units to depart from their schedules to ensure a faithful execution of their dispatching orders issued by Terna. In other words, the dual pricing system can be considered as an “implicit” penalty applied to qualified units that do not respect their schedules. On the other side, not-qualified units do not have the prequalification requirements indicated by Terna in the grid code (see Section 5) and thus they cannot participate to the balancing market. Their imbalances are therefore priced with a single pricing mechanism that is less penalizing than the dual pricing system.²⁶

In order to define the dual and single imbalance pricing systems, the Italian electricity market is currently subdivided into two macrozones: the first is represented by the Northern Italy, while the second includes the rest of the Peninsula in addition to Sardinia and Sicily. For each of this macrozone, imbalance prices depend on:

- The sign of the aggregated zonal imbalance volume
- The sign of the unit imbalance volume

The sign of the aggregate zonal imbalance is given by the algebraic sum, with the opposite sign, of the amount of electricity procured by Terna in the ancillary services market for balancing purposes in that macrozone in each ISP. The imbalance of each macrozone has to be compared with the imbalance of each qualified and not-qualified units located in that macrozone in each of their respective ISP.

For qualified units, the dual pricing system works as described in Table 6:

	Positive Imbalance Qualified unit	Negative Imbalance Qualified unit
Positive Aggregated zonal imbalance	Receive: $\text{Min} [P_{\text{MGP}}, \text{min } P_{\text{MB}\downarrow}]$	Pay: P_{MGP}
Negative Aggregated zonal imbalance	Receive: P_{MGP}	Pay: $\text{Max} [P_{\text{MGP}}, \text{max } P_{\text{MB}\uparrow}]$

Table 6: Dual pricing system for imbalances applied to qualified units (Source: AEEGSI, 2013; Terna 2013b)

Where:

- P_{MGP} corresponds to the price defined in the day-ahead electricity market that is applied to accepted supply offers, in the same ISP, in the zone where the qualified unit is located.

²⁶ Note that, initially, the imbalances of not-qualified units were priced using a dual pricing system. The transition from a dual to a single price system for not-qualified units was introduced in 2005 with the aim of reducing their imbalance costs.

- **Min** [P_{MGP} , $\min P_{MB\downarrow}$] is equal to the lowest price between the P_{MGP} and the $\min P_{MB\downarrow}$ that is the minimum among the prices of the downward (BRPs buy) offers accepted in the balancing market (MB) for balancing in real time, in the same ISP, and in the macrozone where the qualified unit is located.
- **Max** [P_{MGP} , $\max P_{MB\uparrow}$] is equal to the highest price between P_{MGP} and the $\max P_{MB\uparrow}$ that is the maximum among the prices of the upward (BRPs sell) offers accepted in the balancing market for balancing in real time, in the same ISP, and in the macrozone where the qualified unit is located.

The application of a dual pricing system aims at incentivising qualified units to balance the system (optimal solution) rather than their own portfolios (sub-optimal solution, often applied into self-dispatch systems).

For not-qualified units, the single pricing system works as described in Table 7:

	Positive Imbalance Not-qualified unit	Negative Imbalance Not-qualified unit
Positive Aggregated zonal imbalance	Receive: Min [P_{MGP} , $\text{average } P_{MB\downarrow}$]	Pay: Min [P_{MGP} , $\text{average } P_{MB\downarrow}$]
Negative Aggregated zonal imbalance	Receive: Max [P_{MGP} , $\text{average } P_{MB\uparrow}$]	Pay: Max [P_{MGP} , $\text{average } P_{MB\uparrow}$]

Table 7: Single pricing system for imbalances applied to not-qualified units (Source: AEEGSI, 2013; Terna 2013b)

Where:

- P_{MGP} corresponds to the price defined in the day-ahead electricity market that is applied to accepted supply offers, in the same ISP, in the area where the not-qualified unit is located.
- **Min** [P_{MGP} , $\text{average } P_{MB\downarrow}$] is equal to the lowest price between the P_{MGP} and the $\text{average } P_{MB\downarrow}$ that corresponds to the average of the prices of the downward (BRPs buy) offers, weighted by quantities, accepted in the balancing market for balancing in real time, in the same ISP, and in the macrozone where the not-qualified unit is located.
- **Max** [P_{MGP} , $\text{average } P_{MB\uparrow}$] is equal to highest price between the P_{MGP} and the $\text{average } P_{MB\uparrow}$ that corresponds to the average of the prices of the upward (BRPs sell) offers, weighted by quantities, accepted in the balancing market for balancing in real time, in the same ISP, and in the macrozone where the not-qualified unit is located.

Offers are complex as they consider activation costs and energy costs and minimum time window of the service provided.

All BRPs might restore a balanced schedule after generation failure during the intraday market or in real time. This latter causes market based imbalances. Terna can open investigations or inform AEEGSI, the National Regulatory Authority, if suspicious situations require so. Finally, it is not possible for market participants to make re-nominations after real time to avoid imbalance charges.

Note that the current imbalance mechanism based on a zonal representation of the market presents some criticisms, partly due to the higher volatility of energy flows caused by the increasing penetration of intermittent renewable sources. More precisely, the choice of computing the prices of imbalances based on (two) static zones has proved to be an unreliable approximation of the geographical areas in which Terna buys and sells energy in real-time. This choice may lead to an inconsistency that is due to the fact that:

1. On the one hand, Terna buys and sells energy in the MSD at different prices in different network nodes;
2. On the other hand, the imbalance prices are calculated on the basis of a static aggregated balancing zones representation of the market that does not take into account the network lines that are effectively constrained in real time.

As a consequence, the imbalance pricing system currently applied may lead to a misalignment between the value of energy purchased/sold by Terna in real time and the value of the energy purchased/sold by units that face an imbalance, with the consequence that the imbalance price may not correctly reflect the actual costs or benefits caused by the imbalance itself. In addition, some units, especially the not-qualified units subject to a single pricing system, could be encouraged to intentionally imbalance in order to exploit the misalignment between the energy price in real time and the imbalance price. This unfair behaviour can not only influence the process of price formation in the MGP and MI market, but it can also lead to a reduction of the system security and imply some economic costs. This misalignment problem could be overcome with the application of a nodal pricing system to imbalances. This proposal is currently under discussion.

5. Reserves

5.1. Reserve procurement

The MSD ex-ante, operating one day ahead up to a few the real time, is devoted to the procurement of primary (Frequency Containment Reserve, FCR), secondary (aFRR=automatic frequency restoration reserve), and tertiary (spinning and not-spinning, RR=Restoration Reserve) reserve, in addition to the procurement of resources for the congestion management and for other local needs (voltage support, reactive power). Currently, there is no manual secondary control (mFRR) and except for the FCR, aFRR and RR reserves, no additional reserves are procured in the MSD.

As explained in Section 2.3, there is no long-term procurement of reserves. Reserve procurement occurs one day up to a few hours before real time, for a few hours ahead up to the whole lot of hours of the following day. Reserve margins are restored after any day-ahead and intraday session through the ancillary service market (MSD ex-ante) with the corrective logic from day-ahead and intraday schedules (€/MWh up/down).

Qualified units (i.e. BSPs) are obliged to provide bids into MSD ex-ante, which might be selected by Terna, among other purposes, for restoration of reserve margins. In other words, also because of the

public good nature of reserve, the participation to the ancillary service market is mandatory for all qualified units with adequate technical capabilities as defined by the TSO. They present their bids and, differently from what happens in the day-ahead and intraday markets, they are remunerated according to the “pay-as-bid” system. The bid price cap for the upward reserve is the VOLL (3000 euro/MWh), while the floor for downward reserve is zero euro/MWh. We also recall that, up to now, demand and small/intermittent generation facilities are not qualified to bid into MSD ex-ante as they are considered non-dispatchable resource, out the direct control of the TSO.

As indicated in Chapter 4 of the national network code (see Terna, 2015), BRPs qualification requirements depend on reserve type:

1. **Frequency Containment Reserve (FCR)** is provided by all generation units above 10 MVA, connected to the transmission network, with the exception of geothermal and intermittent renewable plants. The units satisfying these prequalification requirements located in Sardinia and in Sicily (when connected to the mainland) must make available a control band not lower than $\pm 10\%$ (upward/downward) of their capacity. The qualified units located in the remaining zones (the rest of the Peninsula) must make available a control band not lower than $\pm 1.5\%$ (upward/downward) of their capacity.
2. **Replacement Reserve (RR)** is provided by all generation units above 10 MVA that are connected to the transmission network, with the exclusion of intermittent renewable generation units and plants that are under commissioning. In addition, these plants have to be able:
 - a) To increase/decrease their injection within 5 minutes from the dispatching order;
 - b) To increase/decrease their injection of, at least, 10 MW within 15 minutes from the dispatching order;
 - c) To execute the dispatching order 24 hours a day, 7 days a week (24/7).

Finally, in the case of basins and pumped-storage hydro plants, their ratio between the amount of electricity that they can provide in one day and their maximum capacity has to be at least equal to 4 hours.

3. **Automatic Frequency Restoration Reserve (aFRR)** can be provided by the units satisfying the requirements foreseen for RR reserve, but, in addition, these units have to be equipped by a specific mechanism enabling them to detect and apply the orders transmitted by Terna and to show the status of the secondary reserve.

Note that the **geographical scope** for the procurement varies depending on reserve type: aFRR is procured separately in Sardinia, in Sicily and in the rest of the Peninsula, while RRs are procured on zonal basis. Terna determines the volume of the FCR²⁷ and aFRR on the basis of the rules defined by ENTSO-E, while the volume of the RR depends on the rules set by the national network code in Annex 22 (see Terna, 2014). The volume of the zonal (upward) RR is determined in such a way that it is possible to face the most detrimental among the following (not-simultaneous) events:

²⁷ It globally amounts to 3000 MW for the whole synchronous area. It is then subdivided pro-quota among countries. See

https://www.entsoe.eu/fileadmin/user_upload/library/publications/entsoe/Operation_Handbook/Policy_1_final.pdf

1. Unforeseen production outages of the largest thermoelectric unit available in the zone;
2. Error (with probability of 99,7%) in demand and intermittent renewable energy production forecast;
3. Production failure of thermoelectric plants under commissioning.

The volume of the zonal (downward) RR is determined in such a way that it is possible to face the most detrimental among the following (not-simultaneous) events:

1. Unforeseen production outages of the pumped-storage plant units with the largest downward rate available in the zone;
2. Error (with probability of 99,7%) in demand and intermittent renewable energy production forecast;

In addition, generation units devoted to procurement of RR have to provide their services without limitation in duration. Finally, in case of reserve failure, a dual pricing scheme is applied.

5.2. Reserve activation time

Reserve activation time also depends on reserve types: FCR, aFRR, and RR have activation times up to 30 seconds, 15 minutes, and 15 minutes up to 2 hours respectively. More precisely, reserves are activated in the following way:

- ✓ Primary reserve (FCR) is automatically activated according to a frequency signal metered at the qualified unit connection point;
- ✓ Secondary reserve (aFRR) is activated by the TSO on pro-quota basis without merit order;
- ✓ Tertiary reserves (RR), spinning and not-spinning, are activated according to their merit order, taking into account system constraints.

5.3. Reserves for balancing energy market

As indicated above, MSD ex-ante is devoted to the procurement of aFRR and RR. aFRR is activated in real-time, while RR can be activated both in MSD ex-ante and MB depending on the technical characteristics of the qualified unit. Their procurement is done through bids that can be submitted after the day ahead and any session of the intraday market. These bids can be updated according to specific rules set by the TSO after MSD ex-ante for their use in real time (for instance, aFRR and RR margins restoration). Bids have 1 MW minimum size and are remunerated pay-as-bids. These bids can be presented by generation units with nominal power above 10 MVA that have qualification requirements similar to those indicated in Section 5.2 for plants procuring RR and aFRR reserves. Finally, according to the technical rules set into the national network code by Terna, demand side and intermittent renewable plants are again excluded.

6. Lesson learnt and challenges

The Italian spot electricity market is composed of three subsequent and integrated submarkets: MGP, MI, MSD. The GME platform does allow for supply and demand to meet, on the other hand it moves forward from this classical role of central European PXs as it acts as a service provider to the TSO in its centralized function, mirroring the logic of the security constrained economic dispatch, though in a simplified way. In fact, the spot market in Italy is a physical market conceived in order to dispatch the electricity system as a whole, manage congestions and allocate transmission capacity in a reliable and efficient way. In this organization, the day-ahead (MGP) and the intraday (MI) markets can be assimilated to forward markets where operators offer/buy electricity which will be available the next day (or in the following hours in the case of MI) to the aim of hedging themselves against price and volume risk associated with the purchase of electricity in real time. In this view, the MSD, whose organization takes inspiration from the US markets based on the ISO model, can be considered as a proxy of the market that really reflects the electricity prices since it operates in real time taking into account all security and network constraints.

The above features represent a tentative to set a coherent approach to the design of the spot markets in Italy. However, on the basis of the national experience and of the European developments, we see some trade-offs and challenges ahead as follows.

First, setting the real-time price right is a challenge by itself. In particular, the definition of the perimeter of the relevant market is paramount for the efficient functioning of the market in terms of price signals. We observed that setting a simplified perimeter of the relevant market not representing the network constraints, or representing them in a rough way, is a trade-off which leads to a certain degree of inefficiency and, possibly, to unfair arbitrage opportunities that can cause significant costs and a reduction of system security (see discussion on nodal pricing system for imbalances in Section 4).

Second, the huge deployment of new technologies - currently well pictured by the intermittent RES and potentially by storage devices, by electric vehicles and by the *known unknowns* - might put the market under unexpected high levels of stress. These changes, which are by definition forecasted just to a limited extent, might also have negative implications on the reliability of the system in the short term and on the adequacy of the system over a longer timeframe.

Last but not least, the European target models introduce further uncertainties in term of efficiency and reliability of the Italian power system functioning. This is because of the leading principles of harmonisation and simplification of the intraday and balancing markets, which, at European level, prevails over efficiency of the design. In particular, specific features as the continuous trading model based on a simplified relevant market, the lack of intraday capacity pricing, the short intraday gate closure time (H-1), the possible interferences of the wholesale market with re-dispatching actions, reserve procurement/activation and real time balancing are some of the critical issues which could have major impacts on the organisation and the efficiency of the market design in Italy.

7. Envisaged objectives and developments

For the period 2015-2018, the Italian National Regulatory Authority aims at reaching two main strategic objectives (see AEEGSI, 2015):

1. **Objective 1:** to make the Italian electricity market more efficient and flexible;
2. **Objective 2:** to increase the degree of integration of the Italian electricity market at European level.

The achievement of **Objective 1** is articulated in the points described below:

- a) AEEGSI intends to enhance the participation of service providers to MSD, including intermittent renewable generation units. This will require, among other things, to improve the definition of services and the performance levels required by Terna in the dispatching phase. Moreover, AEEGSI intends to modify the dispatching rules to make them compatible with the European design of the balancing market as indicated in the Network Code on Electricity Balancing (NC EB)²⁸ and with the evolution towards wholesale energy markets closing short before real time. To this aim, the Regulator will:
 - ✓ revise the criteria and the conditions, which Terna must comply with, for the definition, selection and remuneration of ancillary services, in order to allow for a wider participation of these services by generation, load and storage, according to the criteria of technological neutrality, without compromising the technical requirements and system performances as defined by the TSO. The selection of these services may be formulated for any node of the network or for sets of nodes, according to the constraints of the system;
 - ✓ modify the imbalance pricing rule, in order to reflect the efficient value of electricity in real time on the transmission network, with adjustments set at nodal level, or sets of nodes, defined consistently with the network constraints. This approach, in particular, will be applied to imbalances of qualified units bidding on the MSD.
- b) On a parallel way, flexibility of the Italian electricity markets should be improved, allowing operators to adjust their trading positions as close as possible to the real time. This will also allow generation facilities powered by intermittent renewable sources to take trading positions more in line to their actual generation profiles. In order to guarantee security and efficiency of the system, these foreseen developments must be accompanied by a review of the way in which Terna procures reserves.
- c) Regarding the adequacy issue on the longer term, the priorities will be:
 - ✓ to support any action to speed up the activation of the capacity market (based on the reliability option model) and to reduce the planning horizon for the first implementation. More precisely, according to AEEGSI²⁹, the implementation of the Italian capacity market will be subdivided into two phases. The first will be a preliminary

²⁸ See <http://networkcodes.entsoe.eu/market-codes/electricity-balancing/>

²⁹ See Resolution 95/2015/I/EEL of the 10th of March 2015 available (only in Italian) at <http://www.autorita.energia.it/allegati/docs/15/095-15.pdf>

phase that will start on the 1st of January 2017 and will end on the 31st December 2020. This will be considered as the starting point for the beginning of the second phase of full implementation of the capacity market;³⁰

- ✓ to integrate, to the maximum possible extent, the capacity remuneration mechanism for the participation of resources located outside national borders. This will require a feasibility study, in coordination with the concerned neighbouring TSOs. In particular, Terna will be in charge of reaching agreements with the interested neighbouring TSOs to the aim of defining the participation procedures of foreign generators, load and storage plants. In order to guarantee competitiveness, these procedures has to ensure that the participation of foreign operators is fully equivalent in terms of effects on system adequacy with the participation of national operators;
- ✓ to introduce one or more subsets of the capacity market for the negotiation of flexible capacity, also open to renewable energy systems and electric energy storage, in order to provide price signals of long-term value for flexibility.

The achievement of **Objective 2** is articulated in the two points described below:

- a) Following the day-ahead market coupling with Slovenia, France and Austria, the interaction of the Italian electricity market with other neighbouring markets will face, as a first step, the coupling of the Italian day-ahead market with Greece (by 2018) and possibly to Switzerland (according to the results of the political negotiation with the EU).
- b) Integration of the Italian balancing market with those of other European countries in order to enhance market coordination and to increase the efficiency of flexible capacity.

³⁰ Additional information is available at <http://www.icis.com/resources/news/2015/03/12/9867876/corrected-italy-gears-up-for-2017-electricity-capacity-market-launch/>

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