

Regional Market Of Balancing Electricity: Technical And Economical Analysis

G. D. Stoilov and S. I. Sulakov

Abstract-- During the course of the last two years a Sub group in the frame of Southeastern European Transmission System Operators Task Force (SETSO TF) has been dialing with different problems for design and elaboration of a Regional Balancing Market (RBM) based on TSO-TSO model. This paper describes the technical and economical analyses for South East European power systems and the results, which induce the countries toward more active participation in the processes of establishment of the common power balancing market.

Index Terms-- Regional balancing market and liquidity.

I. INTRODUCTION

Until recently, the transmission system operators (TSOs) in South East Europe have used the so-called mechanism “Emergency Help” to assist each other in case of reserves shortages or unexpected unbalanced situations in real time.

Liberalization of electricity sector makes difficult the further usage of “Emergency Help”. The TSOs are not anymore suppliers and each time have to allocate the delivery of “Emergency Help” to the source and the sink accordingly. The need for replacement of the existing practice by new market-oriented mechanism is obvious. Such replacement should lead to an increase in the regional social welfare. The replacing mechanism appears to be a common regional balancing market [1].

Regional balancing market will start with the exchange of hourly energy products (blocks) among TSOs, which doesn't require major changes in the scheduling practices or market rules harmonization, but can actually bring immediate benefits to the TSOs by allowing access to a wider range of balancing options. After gaining experience with the hourly balancing product RBM should develop and extend to other balancing products, e.g. automatically activated reserves. The long-term goal is to establish a full-scale integrated regional balancing market.

The RBM (plus other intraday cross border trade) will make use of cross border capacities available in the intra-day time frame (no reservation of capacities for the RBM will be required). No congestion payment principle seems to be the only viable solution at the initial stage of the RBM implementation.

The RBM design envisages two management levels, international and local:

- At international level the TSOs act as interface between local balancing energy providers (BEP) and the RBM, hence only TSOs can act as counterparties and any contractual obligations or responsibilities are borne by the TSOs.
- At local level the TSO will handle the relation with the local BEP acting on the RBM and will be responsible for processing offers by local BEP and submitting them to the RBM.

Selection of offers will be made by any TSO individually (decentralized selection) using an ascending price availability list of regional balancing resources so as to minimize the total cost of purchase of this energy subject to transmission capacity constraints. Selection of offers for delivery in hour H of day D, can be made at any time after the closure of local day-ahead market up to one hour before hour H of day D (continuous selection).

Selected offers will be activated locally by the corresponding “connecting” TSO where the offer originates. It is planned that Automatic intra-day scheduling system (via an IT platform) will be developed in some TSOs first as a pilot project and afterwards propagated throughout the region. The IT platform enables TSOs and market participants in the region to exchange balancing energy close to real time. The IT platform processes information about available network capacities, available balancing energy and all corresponding functionality that enables the TSOs to efficiently exchange balancing energy on an international - regional base.

A multilateral inter-TSO agreement will have to be concluded among the interested TSOs. Each regulatory agency will have to address the impacts of the RBM on its own rules/regulations.

II. POTENTIAL BENEFITS OF REGIONAL BALANCING MARKET

The South East European Regional Balance Market represents a kind of balancing market coupling. The opportunity to trade balancing energy via interconnections in case of not-allocated or unused transmission capacity should lead to an increase in operational security of electricity systems and to an improvement in the long-term reliability of electricity supply. Many sources appear recently, because of the importance of the problem [2]-[7]. The RBM should also lead to regional social welfare enhancement as described below.

G. D. Stoilov is with Electricity System Operator of Bulgaria, ESO-EAD, 5, Vesletz St. Sofia-1040, Bulgaria (e-mail: gstoilov@ndc.bg).

S. I. Sulakov is with Electricity System Operator of Bulgaria, ESO-EAD, 5, Vesletz St. Sofia-1040, Bulgaria (e-mail: ssulakov@ndc.bg).

A. More efficient use of balancing resources

At present, there is no market coupling in respect of trading balancing energy in the SEE region. The low cost balancing resources in one country may not be utilized, while more expensive resources are utilized in a neighboring country either by balance responsible parties (BRPs) to fine tune their portfolios given latest expectations of their purchase and sale positions or by TSOs to balance their supply and demand position. If there are no transmission constraints between the two control blocks/areas, RBM should allow low cost balancing resources to be sold at a better price, while the TSOs in need to buy balancing energy at lower price. RBM should allow also relatively high cost balancing resources in one country to be spread in an enlarged environment and to become attractive in another country. As a result reductions in the overall costs of serving demand across the region will occur.

B. Increase of competition

The Implementation of RBM shall increase the competition between balancing energy providers from a national to a regional level. This will result in a potential benefit on balance energy price that will be passed to the customers via a combination of the retail competition and the regulatory regime applied by TSOs.

C. Re-dispatching

Re-dispatching is the contemporary bid and offer balancing requests for same quantity, typically activated by TSOs to solve congestions.

1) Cross-border re-dispatching

Transmission constraints on interconnections between control areas can be most efficiently solved by adjusting generation on both sides of the border through re-dispatching: contemporary bid and offer balancing requests for same quantity by two neighboring TSOs, that due to available transmission capacity (ATC) values, can satisfy transmission constraints of given mutual interconnection.

Actually cross border re-dispatching is allowed just in some countries in case of congestion, through a pro-rata mechanism. The RBM could be a useful tool for cross-border re-dispatching in help of TSOs to enhance the operational network security.

2) Internal-area re-dispatching

Transmission constraints in a control area, in some cases, could be most efficiently solved adjusting both national and cross-border generation, through re-dispatching: contemporary bid and offer balancing requests for same quantity, submitted to RBM by two or more TSOs and activated by one TSO that due to ATC values, can satisfy its internal-area transmission constraints.

III. ANALYSIS ON ECONOMICAL RESULTS

A. Background art

This section presents a qualitative analysis on potential economic results of RBM implementation. The analysis has been conducted adopting liquidity as a key indicator of

performance and efficiency of the market mechanisms.

The analysis has been conducted borrowing economic and finance theory about liquidity indicators of stock markets with the purpose to individuate:

- which level of liquidity we would expect for RBM;
- the best solutions for RBM mechanism design to improve the level of liquidity;

Liquidity is the general characteristic of a market. Liquidity basically means that someone is ready to buy or sell significant quantities of a stock at any time. The level of liquidity is crucial for a market because it is more difficult for participants:

- to adjust their positions and to hedge the risk in a low liquid market: the cost of hedging market positions increases if liquidity decreases;
- to get information: the information flows are impeded when liquidity decreases, as a result the costs for market participants increase.

Based on liquidity importance we start the analysis of proposed RBM by explanation and description of the main factors represented in the figure below that give influence on the RBM liquidity.

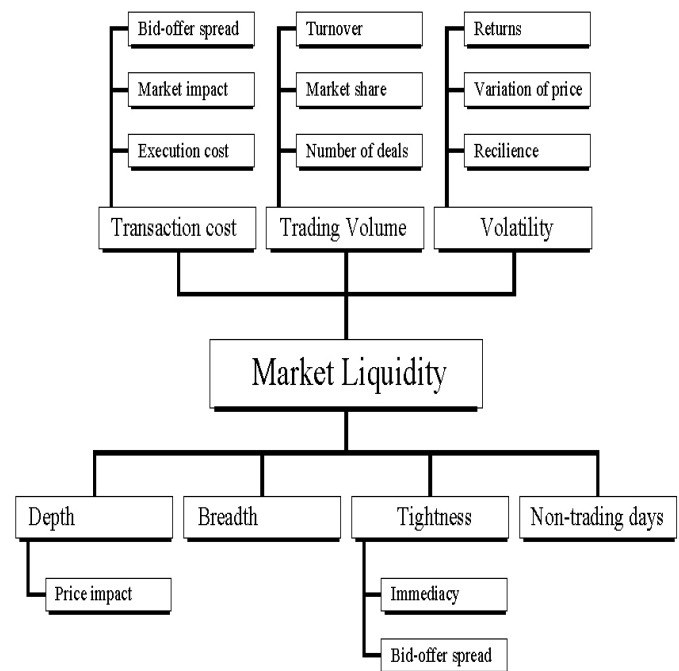


Fig. 1. Liquidity factors

B. Transaction cost

Transaction cost is the cost incurred in making an economic exchange. A commission paid to a broker to buy or sell a stock is an example of transaction cost: the transaction cost of making the stock deal. In the RBM the role of “brokers” is performed by the involved TSOs.

According to the wide spread opinion, TSOs have not to impose extra “RBM fee” because:

- participation to the RBM can be considered as a part of TSOs basic activities, financed by the existing regulated tariffs;
- any “RBM fee” will decrease liquidity of the

mechanism.

According to the opposite opinion, TSOs have to impose extra “RBM fee” in order to reach to acceptable equilibrium in charging the internal users of balancing energy and those abroad. We would recommend not imposing any transaction fee for the exchanges of balancing blocks because this reduces the barriers to the RBM participation and leads improvement in the competition.

In a more general sense, transaction cost refers not only to exchange fees, but also to indirect influences on prices introduced with a price mechanism. In economics, in fact, it is also used to explain a number of different behaviors. Often this involves meaning as “transactions” not only in the obvious cases of buying and selling, but also day-to-day emotional interactions, etc. In other words, the influence of actions for buying and selling on RBM during previous days upon bid/offer prices in the next days on national, accordingly regional level.

There are three measures, which indicate such influence: bid-offer spread, market impact and execution cost.

1) *Bid-offer spread*

Bid/offer spread (also known as “bid/ask spread”) for a stock is the difference between the price available for an immediate sale (bid) and an immediate purchase (ask). The trader initiating the transaction is said to “demand liquidity” and his counter party to the transaction “supplies liquidity”. Liquidity demanders place market orders and liquidity suppliers place limit orders. For a round trip (a purchase and sale together) the liquidity demander pays the spread and the liquidity supplier earns the spread. Otherwise the trade is realized without costs when the bid/offer spread is reduced to zero.

For the RBM two kind of bid/offer spread can be individuated:

- the “unconstrained” bid/offer spread: the difference between the lowest bid price and the highest offer price submitted by TSOs to the market;
- the bid/offer spread available to each TSO: the difference between the lowest bid price and the highest offer price submitted to the market and available to the TSO, due to ATC.

This is very useful information for BRPs in their cross-border trading activities on intra-day (IDM) and day-ahead (DAM) markets. In such case BRPs can find their best position and can hedge their financial risk. Respectively, if there are acceptable differences in prices between areas and free transmission capacities, this will increase competition on regional level and will facilitate cross-border trading on IDM and DAM level.

During the real-time operation without balancing coupling the TSOs responsibility is to balance their own control areas/blocks by activating balancing energy provided by local BEPs, typically under local Merit order criterion. On the RBM TSOs offer blocks and/or activate balancing energy under regional and local Merit order criterion. So TSO that needs balancing energy ask for liquidity provided by other TSOs through RBM or by national BEPs through national

mechanism. Application of the Merit order criterion ensures that the price of activated bid by each TSO from RBM is less, but never higher to the national one, except in case of cross-border re-dispatching. Hence for each TSO it’s important to be informed for the difference in prices between the bid (or offer) with the lowest (or highest) regional price available, due to the ATC values, and the lowest (or highest) price on the national level. This difference is earned by national BRPs, which fall in imbalance on national level. Hence the spread is accordingly a potential for reducing the national and weighted regional imbalance prices. This is also a kind of incentive for the local BEP, which bid/offer has a small chance to be activated on a national level but has a big chance to be activated on the regional level.

The actual balancing energy trade on the RBM, accordingly the real spread, is an indicator for the price forecast and for the tactics of BEPs regarding the price level of their bids/offers for the next hours and day bearing in mind the actual competition. As a result, spreads are often only what the market will bear. Hence RBM will increase competition between BEPs on the regional level and will affect national balancing markets. In addition, as competition grows between market players on the regional level, this pushes balancing market to become increasingly liquid. Than BEPs can sell via TSOs or TSOs can buy on behalf of BRPs significant volumes without a significant impact on market prices level. Consequently, the spread between buy and sell prices narrows. This results in huge efficiency savings along the value chain for the production and sale of balancing electricity.

2) *Market impact*

Market impact is the effect that market participant feels when it buys or sells a stock. This is the extent to which the buying or selling moves the price against the buyer or seller, i.e. upward when buying and downward when selling.

Refer to RBM, dealing on regional level will impact on the national balancing markets in entire region, accordingly on itself. Market impact can arise because the price needs to move and tempt the other BEPs/TSOs to sell or buy balancing energy, but also because BEPs may move their positions towards best profit taking into account that a large BEP/TSO (or a group of BEPs/TSOs) acts one way or another.

3) *Execution cost*

Execution cost measures the difference between the execution price of a stock and the price that would have existed in the absence of trade, which can be further divided into market impact cost and market timing cost.

It was noted above, that in case of RBM, this should lead to difference between execution prices by regional Merit order and the price that would have existed in the region by national Merit orders.

C. *Trading volume*

Trading volume is the amount of the traded quantity in the market during a specified period. Trading volume is influenced by bid-offer spread, offer and demand.

The trading volume on RBM is the amount of activated bids, that in general, depends on many factors as: bid/offer spread, balancing and re-dispatching demand and especially

on unused cross-border available capacity (ATC) free for balancing purposes. So it's intuitive that RBM liquidity will be inherently scarce and for an acceptable level of trading volume to be ensured, a wide participation is desirable.

The trading volume indicators are: value of turnover, number of shares and number of trades.

1) *Turnover*

Turnover is the proportion in percentages between volume of traded stocks and total stocks listed during a specified period, usually a day or a year.

For RBM this is the proportion in percentages between volume of activated bids and volume of total listed bids available, due to ATC values, during a specified period.

As it was said above, the volume of activated bids depends on presence of bid/offer spread, balancing and re-dispatching demand and especially on ATC for balancing purposes.

On the other hand, the volume of the total listed bids in RBM is based on the TSOs estimations on the balancing energy to be traded via RBM after satisfying the requirements on the national level according to UCTE security standards.

Unused transmission capacity, allocated for free for balancing purposes after DAM and IDM, depends on the development of DAM and IDM models on national and regional level, accordingly implementation of implicit or explicit allocation auctions for these time periods. The recent situation in the region indicates that DAM and IDM and auctions are in an initial phase.

In addition the lack of intra-day markets and auctions increases significantly the demand of balancing energy in the control areas of the region, which have to be satisfied in their major part by BRPs before real-time operation. Instead, the entire responsibility for balancing is still assigned in a centralized manner to TSOs.

All abovementioned considerations indicate a significant potential for a large volume of balancing energy for trading via RBM in initial phases, while the establishment of the day-ahead and intra-day markets in all involved countries could lead to a decrease of trading volume via RBM.

2) *Market share*

Market share is the percentage or proportion of the total available market serviced by a company. Number of shares depends on the level of competition.

In the RBM the mechanism will be serviced by TSOs representing BEPs in their control areas due to the scheme adopted by each TSO and approved by national Authority. Referred to RBM, market share is the ratio between the activated volume of balancing energy from a RBM participant and the whole activated volume (distinguishing upward and downward activations). RBM has inherent low liquidity. That is why the concentration of maximum BEPs on a potentially single virtual market based on significant number of balancing offers/bids contributes to reach the maximum possible liquidity for the RBM. Therefore participation of more countries on regional level is recommended.

3) *Number of deals*

Number of deals is the number of trades or transactions done in a specified period. In the RBM number of deals

corresponds to the number of activations, that depends on ATC, balancing and re-dispatching demand, submitted volume, price spread, the procedure "first come-first served" and accordingly on TSOs actions. In case of fixed volume for submitted and activated bids and offers, the number of deals also represents the activated volume on RBM.

D. *Volatility*

Volatility is degree of price fluctuation for a given stock, that measures price variability in a market. Volatility indicators are: returns, variation of price and resilience.

1) *Returns*

Returns are defined by the change/difference in the value of a portfolio over a specified evaluation period, including any distributions made from the portfolio during that period. In the case of RBM implementation, revenues caused by decreasing the payments for imbalances of BRPs and increasing of revenues of BEPs in bid/offer process during the relevant period should measure the returns. The Returns with regard to TSOs can be estimated as the change in their total costs for providing system services caused by this additional tool (RBM) for balancing the control blocks/areas and for increase the security of supply.

2) *Variation of price*

Variation of price is usually expressed as a variation or standard variation of prices for a specified period. Variation of balancing energy price in involved countries from the region is influenced by many factors, such as:

- level of lifestyle;
- volatility of electricity wholesale market price;
- climate and weather conditions;
- influences of primary energy resources price;
- planned and forced outages;
- plants management;
- national balancing mechanism model;
- etc.

All these factors will determine initial wide variation range of prices on national and regional level during the period proceeding to RBM operation start. As a result of RBM continuously trading, under perfect competition hypothesis, variation of prices on the national and the regional level will reduce. This will mitigate the imbalance prices fluctuations, and would reduce the volatility of DAM prices.

3) *Resilience*

Resilience represents the speed at which prices return to a new equilibrium once the impact of a large trade has dissipated, in other words, the speed at which new stock orders respond to a change in prices. Resilience is often indicated by price volatility with respect to a traded volume.

A concept related to resilience is the so-called normal market size. The basic idea is that there is a normal market size above which the size of the trade may move prices on its own. This is typically a percentage of the typical volume traded on a typical day, below which it is assumed that there will be no significant price movement due to a single trade.

It is difficult to predict the resiliency or the spread at which new bids/offers will be submitted because of many unpredictable factors. Nevertheless an acceptable resilience

could be expected if all TSOs in the Region participate to the proposed RBM. On the other hand at D-1 bids and offers are submitted to the national Merit orders and then on the execution day D bids and offers are transferred by TSOs to the RBM. Therefore, we expect that the speed at which BEPs would respond to a change in prices on RBM level will be close to D-1 resilience, which will provide protection against speculation and manipulation on RBM.

E. Depth

Depth measures the volume of trading needed to significantly affect prices.

Depth is typically measured by price impact, which is the amount of price changes based on the quantity traded. If large trade doesn't affect price much, then the market is assumed to have a great depth. As it was mentioned above, RBM trading volume depends on too many factors that we could assume RBM inherently scarce in trading volume, so that opportunity for large trade is very low probable as their potential impact on prices. Therefore we could expect that a great depth would characterize RBM.

F. Breadth

Breadth of the market is a percentage of stocks participating in a particular market move. Usually it's assumed that breadth is significant if two-thirds of the stocks listed on an exchange move in the same direction during a trading session.

Market movement in RBM depends on balancing demand in involved countries, difference in prices, ATCs values and TSOs activities. In addition, a particular market move on BEPs side is one day after trading session. Therefore it can be expected that RBM would have no significant breadth.

G. Tightness

Tightness of a market is the cost and speed of turning a position around, in other words the ability to match supply and demand rapidly.

Tightness is typically measured by: immediacy and bid/offer spread.

As bid/offer spread was analyzed above, immediacy is the cost and speed of order matching. On RBM level, TSOs have to estimate the cost of order matching (bid-offer spread, system balancing requirements) and after this estimation in case of positive balancing market financial and technical results to act on RBM. Therefore, after a first period of implementation of RBM a high level of immediacy is expected.

H. Non-trading days

Non-trading days are specific days during which transactions are not allowed. This break can introduce significant discontinuity from previous closure and following open of the market, because of the ongoing change of relevant factors. Continuous trading hour by hour proposed for RBM annuls the non-trading days and provides more opportunities to enlarge volume of RBM trading and to improve liquidity.

IV. CONCLUSIONS

The essential characteristic of a liquid market is that there are ready and willing buyers and sellers at all times.

Establishment of the RBM provides synergy effect for improvement of the physical liquidity in each control area balancing because the RBM serve an additional mechanism for TSOs and BEPs. However a high level of participation in RBM is not enough to ensure liquidity of the mechanism, because buying and selling balancing energy is subjected to many constraints as:

- technical constrains;
- ATC values;
- balancing demand in the control areas/blocks;
- bid/ask spread;
- dispatcher actions.

A part of the discussed analysis about liquidity indicates good results in respect of RBM. Another part shows the negative effect. However it is assumed that the volumes traded will be relatively small and market liquidity will be low. This situation will progress with the implementation or improvement of the Day-ahead and Intra-day markets in all involved countries. Nevertheless, the expectations indicate adequate level of liquidity for such type of market. In addition, if there are possibilities to trade balancing energy via interconnections, it has to be facilitated and this corresponds to further development of the Internal European Electricity Market.

Besides the liquidity, the general performance of a market is illustrated by a system of indexes. For the case of RBM such indexes have to be created in order to facilitate balancing energy providers and TSOs.

The goal of the RBM implementation is to achieve the following basic outcomes: truthfulness, individual rationality, budget balance and social welfare.

While, as we note above, these analysis are aimed at providing an insight into the broad order of magnitude of the potential benefits rather than trying to estimate them accurately, it would appear from this paper that, there are reasonably economic benefits to be gained from RBM implementation.

Summarizing the analysis provided in this document regarding economic categories of RBM we would like to emphasize our feeling that RBM could satisfy the equilibrium requirements of the participating TSOs.

V. ACKNOWLEDGMENT

The authors gratefully acknowledge the contributions of Maria Antonietta Sidoni for her work on the original version of this document.

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VII. BIOGRAPHIES



Georgi Stoilov was born in Svilengrad in Republic of Bulgaria, on August 23, 1944. He graduated the Technical University of Sofia. His employment experience includes the National Dispatch Center of Electricity system operator, Sofia, and Central Dispatch Control of United Power Systems in Prague, Minister of Energy and energy resources in Bulgaria, Chairmen of the State Energy Efficiency Agency. His special fields of interest include power systems planning, development and control, power market liberalization, and energy

efficiency.



Stefan Sulakov was born in Plovdiv in Republic of Bulgaria, on October 13, 1974. He graduated the Technical University of Sofia. His employment experience includes the South East Electricity Distribution Company in Plovdiv and National Dispatch Center of Electricity system operator, Sofia. His special fields of interest include power systems operation planning and control, and power markets sustainable development.