ANALYSIS OF THE RESULTS USING THE FORMULAS FOR CALCULATING THE COMMERCIAL CODE PROJECTIONS 2009 ON COSTS AND PRICES FOR THE SECONDARY REGULATION

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Abstract: The Balancing Market which is in operation since July 1st, 2005, created the competition based legal framework for buying and selling the balancing energy, by the Romanian TSO, used to eliminate the imbalances arising during the operation and the management of network congestions. Since then, the Romanian Transmission and System Operator (TRANSELECTRICA S.A.) have begun its activity as Balancing Market Operator. This market is based on the Commercial Code of the Wholesale Electricity Market, which was published back in 2004. After a couple of years, the Romanian Regulatory Authority (ANRE) proposed a new Wholesale Electricity Commercial Code, which is under discussion since 2007. There are some changes proposed, most of them on the Settlement chapters, regarding the cost for the secondary regulation. The present paper proposes to compare the resulting Secondary Regulation prices based on the actual and the proposed Commercial Code of the Wholesale Electricity Market.

Keywords: Secondary Regulation, Commercial Code, Balancing Market.

1. Introduction

The Balancing Market is operated using a complex computer platform. During the last decade, continuous improvements of this platform have been brought, moreover, back in 2009, Transelectrica S.A. started a project in order to purchase a new platform capable to integrate all the functional operation of electricity markets that are in its own administration, namely: Balancing Market, Ancillary Services Market and Capacity Allocation Market. [4]

Romanian Balancing Market was conceived as a tool for balancing Romanian Power System and operates with three types of Frequency Regulation: Secondary Regulation, Slow Tertiary Regulation, and Fast Tertiary Regulation.

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Primary Frequency Regulation is mandatory for all power producers (dispatchable and non-dispatchable generation units), not being paid on Balancing Market. In Romanian Electricity Market, the Ancillary Reserves are paid distinctively (divided into two parts: regulated quantities with the corresponding prices, and non-regulated quantities for which the Transmission and System Operator organizes open auctions), according to the Dispatch Orders released by the TSO, which are also paid separately based on the participant daily offers. Exception to this rule is Secondary regulation price, which is established as a marginal price for upward and downward regulation and it is paid for the accomplished quantities. [1]

2. Calculation of the Secondary Regulation price, a comparison between Actual and Proposed (under discussion) Commercial Code of the Wholesale Electricity Market

According to the actual Wholesale Electricity Commercial Code, the Secondary Regulation energy is paid on marginal price as following: using the dedicated software, Balancing Market Operator selects the available Secondary Regulation Band for one or more intervals. For each dispatching interval, the merit order is settled for balancing energy corresponding to upward / downward Secondary Regulation, combining in one offer all price-quantity bidding pairs. The highest / lowest price of such a pair for the balancing energy corresponding to upward / downward Secondary Regulation, partly or totally accepted, determines the marginal price for the balancing energy. The IT platform establishes the upward and downward prices for each selected unit (Fig. 1)

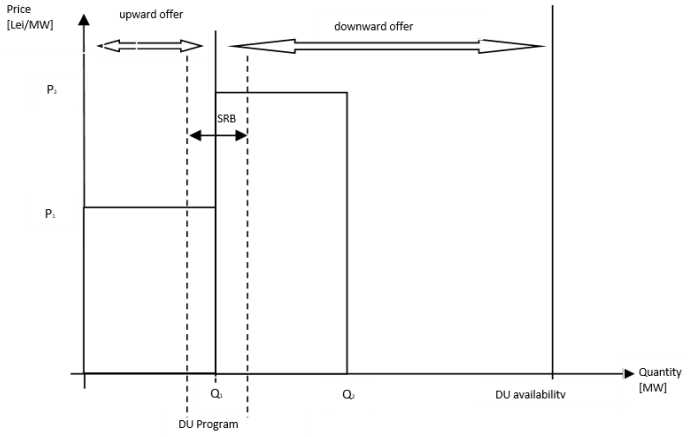

Fig. 1 Typical Daily Offer on BM for one interval

A typical daily offer on one interval is presented in the above figure. It depicts an offer with two price-quantity pairs. It also represents the functioning program of the dispatchable unit (physical notification) for the given hour, the available quantity of the given hour and the selected secondary regulation band (SRB). It can easily be seen that for this particular dispatchable unit (DU), the downward regulation price is P1 and the upward regulation price is P2. On a given hour, the marginal upward price is the maximum from all selected upward prices and the marginal downward price is the lowest price from all selected downward prices. The realized quantities to be paid are calculated by the AGC (Automatic Regulator) and delivered automatically to the Balancing Market System each day for the delivery (previous) day. A very important mention is that the calculated upward and downward quantities are actually the realized ones. [2]

2.1. Negative values for Balancing Market Participant costs on downward secondary regulation

We are using as example the 1st interval of January 1st, 2014, in order to present the negative values costs on downward secondary regulation if we used the proposed (under discussion) Wholesale Electricity Commercial Code. [3]

Table 1

Example: the 1st interval of January 1st, 2014

UNIT	Delivered Upward [MWh]	Delivered Downward\ [MWh]	Max price Upwad [lei/MWh]	Min Price Downward [lei/MWh]	$Spr_{sec,M\ arg}$ [lei/MWh]	Selected bandwidth [MW]	Income Sec_up [lei]	Cost_ Sec down [lei]
UD_H1	21.291	0.151	101	1	100	116	2736.191	**-5.649**
UD_H2	18.355	0.13	101	1	100	100	2358.855	**-4.87**
UD_H3	20.19	0.143	101	1	100	110	2594.69	**-5.357**
UD_G	3.671	0.026	315	215	100	20	1471.365	**-209.41**
UD_T	5.506	0.039	104	4	100	30	728.624	**-5.844**

The formulas used for secondary downward calculation are [2]:

$$P_{sec,R}(t,d,i) = P_{sec,R,delivered}(t,d,i) - P_{sec,R,Min}(t) \quad (1)$$

R is used for downward secondary regulation where:

$P_{sec,R,Min}(t)$ - represents the minimum income for the selected *secondary regulation* band adequate to the *transaction* t; [Lei]

$P_{\sec,R,delivered}(t)$ - payment obligation for the *balancing energy* corresponding to the *downward secondary regulation* delivered, adequate to the *transaction* t;

i - dispatch interval i

d - day d

$$P_{\sec,R,Min}(t) = \frac{1}{2} \times f \times p(t) \times q_b(t) \tag{2}$$

where:

f - band factor for *secondary regulation* (established by the Authority);

Note: The value of band coefficient (f) was chosen 0.1 to illustrate the calculus

$p(t)$ - price, respectively quantity corresponding to the *transaction* t; [lei/MWh]

$q_b(t)$ - *balancing energy* corresponding to the *secondary regulation band* adequate to the *transaction* t; [MWh]

$$P_{\sec,R,delivered}(t,d,i) = p(t) \times q_{delivered}(d,i) \tag{3}$$

where:

$q_{delivered}(d,i)$ - *balancing energy* corresponding to *downward secondary regulation* delivered by the *Balancing Market participant*, in the *dispatch interval* i of day d

And:

$$p(t) = \frac{p_{\max,\sec,C}(k,d,i) + p_{\min,\sec,R}(k,d,i)}{2} - \frac{Spr_{\sec,M\,\arg}(d,i)}{2} \tag{4}$$

$$Spr_{\sec,M\,\arg}(d,i) = Max\left\{\left(p_{\max,\sec,C}(k,d,i) - p_{\min,\sec,R}(k,d,i)\right) \quad \forall \quad k \in K\right\} \tag{5}$$

C is used for upward secondary regulation

where:

$p_{\max,\sec,C}(k,d,i)$ - the highest price of any price-quantity pair of the *dispatchable unit* k that was chosen for delivering the

balancing energy corresponding to the *power upward secondary regulation* in the *dispatch interval* i of the day d;

$p_{\min,sec,R}(k,d,i)$ - the lowest price of any price-quantity pair of the *dispatchable unit* k that was chosen for delivering the *balancing energy* corresponding to the *downward secondary regulation* in the *dispatch interval* i of the day d;

$Spr_{sec,M\,arg}(d,i)$ - marginal distribution for delivering the *balancing energy* corresponding to the *secondary regulation* in the *dispatch interval* i of day d. M_{arg} represents notation for marginal distribution.

The definitions are as proposed on Electricity Market Commercial Code Project III 2009. [2]

In the case shown in the table 1, for generation unit UD_G, considering the offer we had:

$p_{\max,sec,C}(k,d,i)$=315 lei/MWh and

$p_{\min,sec,R}(k,d,i)$ = 215 lei/MWh,

the downward secondary price using (4) becomes:

$p(t)$ = (315+215)/2 - 100/2 = 215 lei/MWh

$Spr_{sec,M\,arg}(d,i)$=100 lei/MWh - this value was established by comparing the difference between the maximum secondary upward price and the minimum secondary downward price for the proposed interval.

Using (2):

$P_{sec,R,Min}(t)$ = 1/2 x 0.1 x 215 x 20 = 215 lei (bandwidth factor value *f* is 0.1)

Using (3):

$P_{sec,R,delivered}(t,d,i)$ = 215 x 0.026 = 5.59 lei

Using (1):

$P_{sec,R}(t,d,i)$ = 5.59 – 215 = **-209.41 lei** (negative value)

2.2. For zero upward secondary delivered energy incomes of Balancing Market Participant are greater than zero.

In order to outline this situation, the 6th interval of January 1st, 2014 is used.

Table 2

Example for the 6th interval of January 1st, 2014, for 0 MW upward delivered secondary energy

UNIT	Delivered Upward [MWh]	Delivered Downward [MWh]	Max price Upwad [lei/MWh]	Min Price Downward [lei/MWh]	$Spr_{\text{sec},M\ \text{arg}}$ [lei/MWh]	Selected bandwidth [MW]	Income Sec_up [lei]	Cost_ Sec_down [lei]
UD_H1	0	47.578	101	1	100	116	585.8	41.778
UD_H2	0	41.015	101	1	100	100	505	36.015
UD_H3	0	22.969	101	1	100	56	282.8	20.169
UD_G	0	8.203	315	215	100	20	315	1548.645
UD_T	0	12.305	104	4	100	30	156	43.22

The formulas used for secondary upward calculation are:

$$P_{\text{sec},C}(t,d,i) = P_{\text{sec},C,Min}(t) + P_{\text{sec},C,delivered}(t,d,i) \quad , \tag{6}$$

$$P_{\text{sec},C,Min}(t) = \frac{1}{2} \times f \times p(t) \times q_b(t), \tag{7}$$

$$P_{\text{sec},C,delivered}(t,d,i) = p(t) \cdot q_{delivered}(d,i), \tag{8}$$

Where: $p(t) = \dfrac{p_{\max,\text{sec},C}(k,d,i) + p_{\min,\text{sec},R}(k,d,i)}{2} + \dfrac{Spr_{\text{sec},M\ \text{arg}}(d,i)}{2}$

and

$$Spr_{\text{sec},M\ \text{arg}}(d,i) = Max\left\{\left(p_{\max,\text{sec},C}(k,d,i) - p_{\min,\text{sec},R}(k,d,i)\right) \quad \forall \quad k \in K\right\} \tag{9}$$

$P_{\text{sec},C,Min}(t)$ - represents the minimum income right for the delivered selected secondary band, for transaction t;

$P_{\text{sec},C,delivered}(t,d,i)$ - represents the income for the upward delivered (realized) secondary energy for day d, interval i, and transaction t;

f - represents the bandwidth factor for secondary energy (established by the Authority)

$p(t)$ - represents the Price corresponding to the transaction *t*

$q_b(t)$ - represents the selected secondary band;

$q_{delivered}(d,i)$ - represents the realized upward secondary energy for interval *i* corresponding to the transaction day *d*;

As an example, we use the data in table 2 for unit UD_G in order to calculate the secondary upward price.

Using (9):

$p(t) = (315+215)/2 + 100/2 = 315$ lei/MWh

$$P_{\text{sec},C,Min}(t) = \frac{1}{2} \times f \times p(t) \times q_b(t)$$

Using (7):

$P_{\text{sec},C,Min}(t)$ = 1/2x 0.1x 315 x 20 = 315 lei (Bandwidth factor value is 0.1)

$Spr_{\text{sec},M\,\text{arg}}(d,i)$ = 100 lei/MWh - this value was established by comparing the difference between the maximum secondary upward price and the minimum secondary downward price for the proposed interval.

Using (8):

$P_{\text{sec},C,delivered}(t,d,i)$ = 315 x 0 = 0 lei

Using (6):

$P_{\text{sec},C}(t,d,i) = 315+0 = 315$ lei

3. The balancing energy related to the secondary regulation

For each dispatch interval, the TSO determines the merit order for the balancing energy corresponding to the upwards secondary regulation, sorted ascending by price, starting with the price-quantity pair having the lowest price.

For each dispatch interval, the TSO determines the merit order for the balancing energy corresponding to the downwards secondary regulation, sorted descending by price, starting with the price-quantity pair having the highest price.

Based on the values established for the necessary reserve related to the secondary regulation, TSO will accept price-quantity pairs from the merit order for the balancing energy corresponding to upward and downward secondary regulation, respectively, according to certain conditions. One of these conditions stipulates that for each dispatchable unit the total quantity for balancing energy from the accepted price-quantity pairs corresponding to upward secondary regulation will be equal to the total quantity for balancing energy from the accepted price-quantity pairs corresponding to downward secondary regulation.

The Dispatchable Units that have been requested to make available a certain regulation margin (RM [MW]) for secondary regulation will deliver balancing energy (W_{sr} [MWh]) related to the secondary regulation, answering the signals received from the central regulator of TSO in a real time manner.

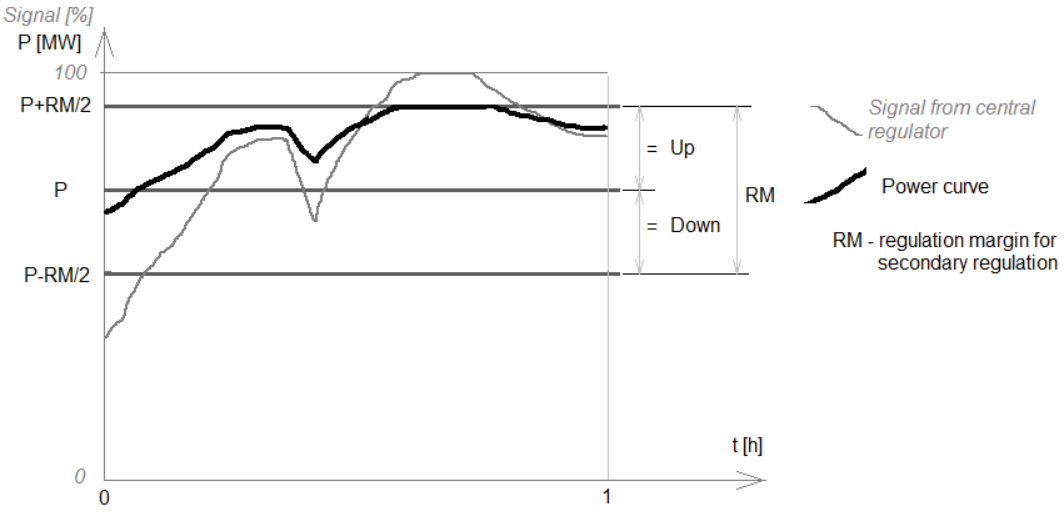

Fig. 2. Regulation margin for secondary regulation

The balancing energy related to the secondary regulation (W_{rs}) corresponds to the area bordered by the power curve (P) of the dispatchable unit. [2]

$$W_{rs} = [(P\text{-}RM/2) + RM * s/100] * t \quad (10)$$

where:

W_{rs} – represents the balancing energy related to the secondary regulation

P – physical notification (power)

RM – regulation margin for secondary regulation

s – signal received from the central regulator of TSO

4. Conclusions

In the present paper the author investigated a case using the proposed formulas. Negative values of costs for on downward secondary regulation are obtained when downward realized quantities are small, "income" is larger than the payment, therefore the result of the calculation is negative. In conclusion, negative cost may be considered as an income and as a result, by applying the proposed formulas, Balancing Market Participant (BMP), although was reducing the power, has to receive an amount of money as a part of the minimum income rights.

Within the paper the author proposes to replace with zero the negative costs.

In the second case pointed in the present paper, when zero upward secondary delivered energy income of BMP is greater than zero, and BMP has an income even in the situation when the realized upward, secondary quantity is zero.

The proposal is to replace with zero the secondary regulation income when the realized quantities are zero.

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R E F E R E N C E S

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