Dashboard for analysis of electricity imbalances at the Balancing Responsible Parties level

Simona-Vasilica OPREA[1], Adela BÂRA[1], Ciprian Georgian DRAGOMIR[2], Osman Bülent TÖR[1,3], Ștefan PREDA[1]
[1]Bucharest University of Economic Studies
[2]CEZ Romania
[3]EPRA, Engineering Procurement Research Analysis, Ankara, Turkey
simona.oprea@csie.ase.ro, bara.adela@ie.ase.ro, ciprian.dragomir@cez.ro, osman.tor@epra.com.tr, spreda2003@yahoo.com

The paper presents the Dashboard for the analysis of imbalances at the level of a Balancing Responsible Party BRP (ABI-PRE). It describes the allocation between the members of a BRP of the costs/revenues generated by the net imbalances of the respective BRP and the calculation methodology implemented within the IT prototype. The reports created within the ABI-PRE Dashboard are generated following the analysis of specific indicators (contribution of BRP members to imbalances, revenues/expenses resulting from internal redistribution, additional revenues/expenses from system balancing, share of imbalance at BRP level, ratios between adjusted average prices and average prices on the Balancing Market) and BRP performance (BRP efficiency).
Keywords: *balancing market, balancing responsible parties, surplus, deficit, cost allocation method*

1 Introduction

The rules for the functioning of the balancing market and the determination and settlement of imbalances need to be harmonized with European regulations. Commission Regulation (EU) 2017/2195 laying down a guideline on the balancing of the electricity system [1] provided, at European Union level, a set of technical, operational and market rules governing the functioning of balancing markets, including rules on the financial settlement of the BRP. At the ENTSO-E level, the Implementation Framework document was developed referring to the proposal created by all Transmission System Operators (TSOs) on the framework for the implementation of a European Platform for the process of compensating for imbalances, in accordance with [1]. Pursuant to Article 22 of [1], all European TSOs have developed a joint proposal for the framework for the implementation of an European Platform for the process of offsetting imbalances, setting out rules on activating energy balancing and financial settlement of BRP.

Given that energy balancing offers will compete on balancing platforms across the EU, this will also have a positive effect at the competition level. It will also contribute to the goal of transparency in balancing markets, as the same rules and methodologies will apply to all TSOs.

After the entry into force of [1], it was necessary to adapt the legislation in the field, in accordance with the methodologies proposed by TSO and approved by national energy regulatory authority (ANRE). The rules for the transparency of balancing settlement were approved [2]. Any BRP has the responsibility to redistribute monthly to its members the additional income, respectively the additional cost from balancing the system, based on the contribution of each licensee (BRP member) to reduce, respectively to amplify the imbalance of the power system level.

Another stage in this process was the elaboration by TSO and the approval by ANRE of the clauses and conditions applicable to the BRP, which must comply with the framework terms for the creation of

European platforms for energy balancing exchange and for the process of compensation for imbalances. The proposal on the terms and conditions for the parties responsible for balancing [3], created by TSO, establishes rules for the registration of licensees as BRP, withdrawal/revocation of registration as BRP, delegation of balancing responsibility to other BRPs, transmission of data and information delivered to the TSO for the purpose of calculating the imbalance on each imbalance settlement interval; determining the imbalance generated by a BRP in each imbalance settlement interval, etc.

The Regulation for the calculation and settlement of imbalances of the parties responsible for balancing has been approved [4], which contains the rules for the registration and aggregation of parties responsible for balancing and for the determination and settlement of imbalances between production and consumption. At the same time, the correlation of the way of determining the imbalances with the transactions on the balancing market brings coherence and is in line with the European trends, necessary for the creation of the internal energy market.

To cover the differences between the planned/contracted values of consumption, respectively production and their values in real time, the TSO operates the balancing market, buying or selling energy considering the offers of dispatchable producers. The market participants that determine the imbalances, organized in BRPs, financially bear the value of these imbalances, paying for the energy deficit the price resulting from the increasing offers accepted on the balancing market, respectively receiving for the energy surplus the price resulting from the decreasing offers accepted by the system operator.

Using records from the balancing market databases, the TSO produces weekly, monthly and annual reports (for example, traded volumes, monthly values of transactions on the balancing market, the average square deviation of physical notifications and consumption forecast).

Participation in a BRP (own or delegating the balancing responsibility to another BRP) is mandatory for any licensee (producer, supplier, trader, distributor) who is active in the energy market and performs transactions. The activity of each BRP aims to balance the differences between the contracted electricity and the electricity measured at the level of the entire contour.

According to [2], each BRP applies uniformly the method of internal allocation of imbalances for all licensees who are members of the respective BRP.

According to the *procedure* on the allocation of imbalances registered in the Electricity Balancing Market, drawn up by each BRP according to the national legislation and which applies to all members of that BRP, the imbalances of the BRP members result as a difference between the notified quantities (sold/bought in the wholesale electricity market) and the measured quantities of electricity. The sum of the individual costs of the BRP members is always equal to the BRP costs and all participants always benefit from the advantages of aggregating the imbalances, but not necessarily in equal proportions at monthly level. The method of internal redistribution of payments ensures that all participants included in the respective BRP always benefit from the aggregation of imbalances.

According to [4], Annex no. 2, rules are established for:

a) the registration of licensees as BRP, the withdrawal/revocation of registration as BRP, as well as the delegation of balancing responsibility to other BRPs;

b) determining the imbalance generated by a BRP in each dispatching interval;

c) the settlement of imbalances of the BRPs in a way that reflects the costs of balancing

the system, and the BRPs to be encouraged to balance before delivery and not to aggravate the imbalance of the system.

2 BRP activities and ABI-PRE module description

With the application of the provisions [4], the additional income, respectively the additional cost coming from the balancing of the system is redistributed monthly to each BRP, starting from its contribution to the reduction or aggravation of the system imbalance.

The allocation among the members of a BRP of the costs/revenues generated by the net imbalances of the BRP is performed for each time interval, according to the calculation methodology (*procedure*) which consists in determining:

- the net contractual position, for each BRP member, on the basis of hourly notifications of production or consumption for the following day, sent to the BRP by each member;
- the net contractual position at BRP level;
- the net measured position for each BRP member, based on the actual measured values received from the Distribution System Operator (DSO)/TSO;
- net position measured at BRP level;
- the imbalance of each BRP member;
- imbalance at BRP level;
- the amount of imbalances for each BRP member, for each time slot, based on deficit and surplus prices;
- the value of the imbalance for BRP;
- the sum of the values of the individual imbalances at the level of the entire BRP;
- total gain at BRP level;
- unit gain;
- revised deficit/surplus prices, applicable internally at BRP level;
- the hourly costs/revenues of each member of the BRP according to the imbalance of each member, resulting from the internal redistribution of the costs/revenues related to the imbalances;
- the direct contribution (direct cost/direct income) and the indirect contribution (indirect cost/indirect income) of each member of the BRP to the total imbalance of that BRP;
- the total cost/income of each member, respectively at the BRP level.

The percentages of the distribution of the total revenues/costs of each member of the BRP are determined. The redistribution of additional costs/revenues from the balancing of the BRP system to the BRP members is determined on the basis of the contribution of each licensee and each BRP, in each settlement interval, to the reduction of the system imbalance, respectively to the increase of the power system imbalance. The allocation of additional costs/revenues is performed in proportion to the resulting imbalance to the licensees according to the position (sign) of the SEN, the BRP and the licensee (BRP member), for each settlement interval. The additional costs/revenues from the balancing of the system, related to BRP, are distributed to the BRP members.

The following indicators for the evaluation of efficiency at the BRP level are determined:

- the share of the total energy imbalance at BRP level
- the ratio between the rectified average prices at the BRP level/the average prices on the Balancing Market (negative imbalances and positive imbalances):
- BRP efficiency calculated as the difference between the average deficit/surplus price within the BRP and the average deficit/surplus price of the market operator.

All calculations are made separately for each settlement interval. The presented methodology is implemented within the computer prototype developed by the authors of this paper [5]. The data is stored in the database, and the ABI-PRE module developed in Power BI connects to the database. The reports created within the

ABI-PRE module are grouped following the analysis of the following indicators:
a) The contribution of BRP members to imbalances;
b) Revenues and hourly expenses of BRP members resulting from the internal redistribution of imbalances costs/revenues;
c) Additional revenues and expenses from balancing the system;
d) The share of the total energy imbalance at BRP level;
e) The ratio between the rectified average prices and the average prices on the balancing market;
f) BRP efficiency.

For the analysis of the contribution of BRP members to imbalances, reports were constructed through which the values of the following indicators can be analysed: Contractual net position, Measured net position and Imbalance. Each of the reports are displayed in a separate window including pie charts and stacked columns format, and tables. In Fig. 1 below, it is presented an example report.

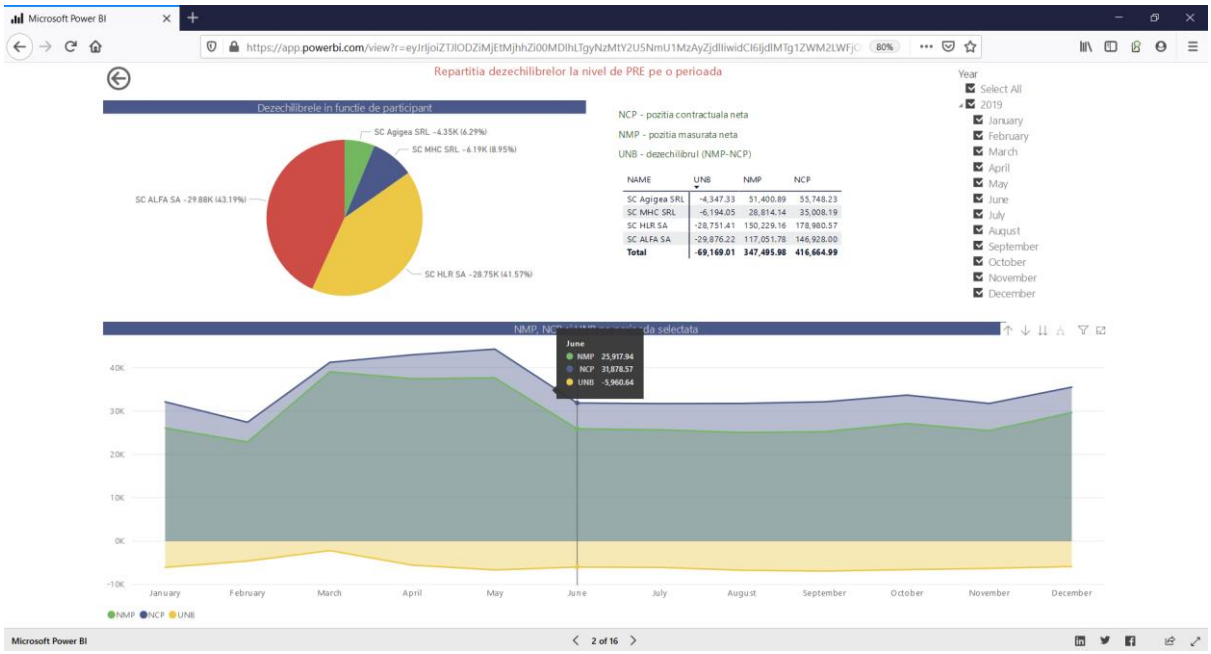

Fig. 1. Distribution of imbalances at BRP level

The distribution of imbalances at the level of BPR analyses the distribution of imbalances on the members of BPR, for a certain selected period of time.

The share of imbalances recorded by BPR members over a selected period of time is presented in the report Structure of imbalances at BPR level (as in Fig.2).

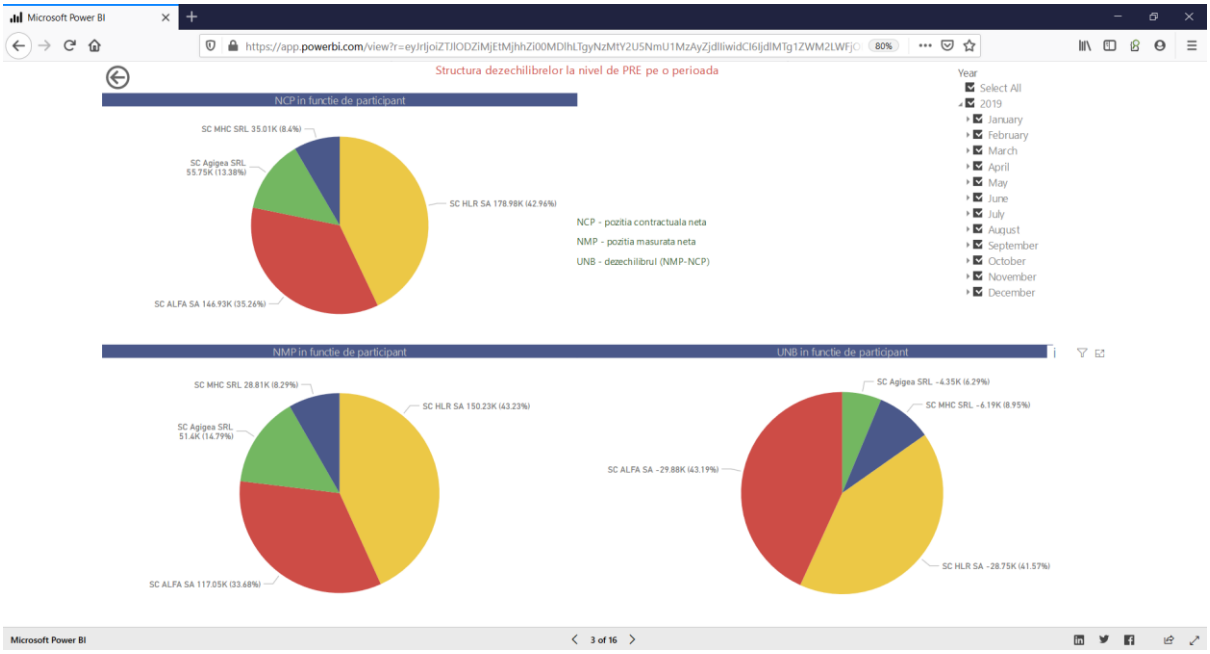

Fig. 2. The structure of imbalances at the level of PRE

For the analysis of the evolution of the indicators: net contractual position, measured net position and imbalances at hourly intervals, during a day, the report Hourly evolution of imbalances at BRP level can be used (Fig. 3).

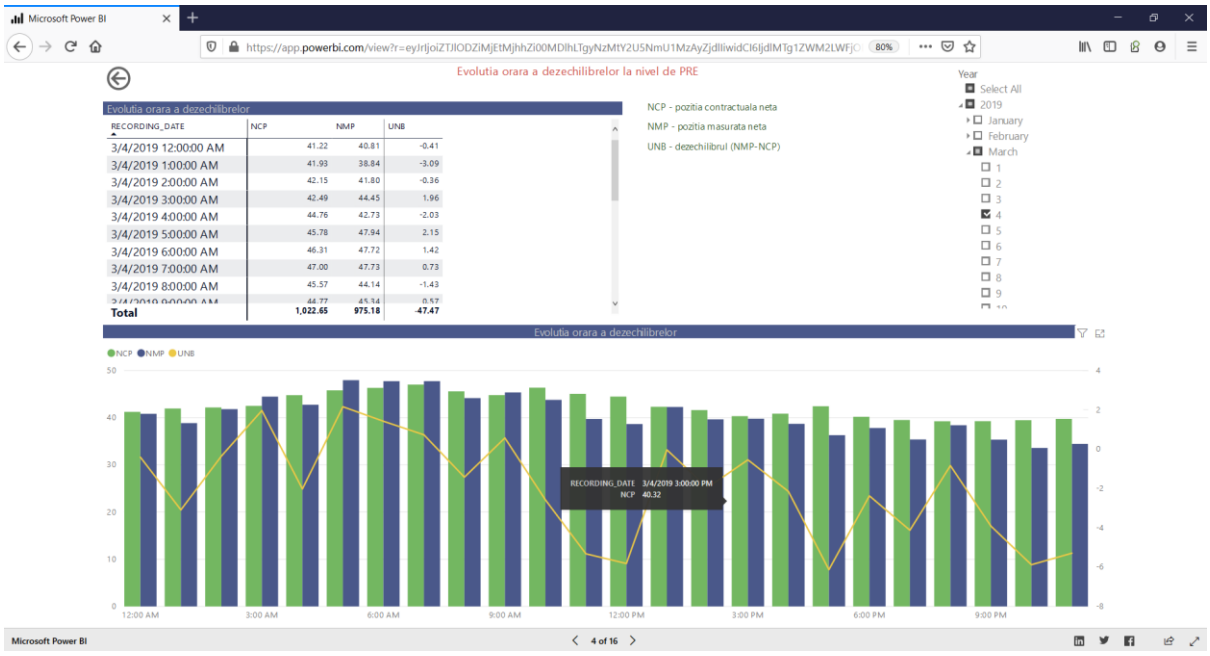

Fig. 3. Hourly evolution of imbalances at PRE level

Imbalances, as well as indicators of the net contractual position and the measured net position can be analysed for a specific chosen participant, based on the hourly evolution, over a 24-hour period (Fig. 4).

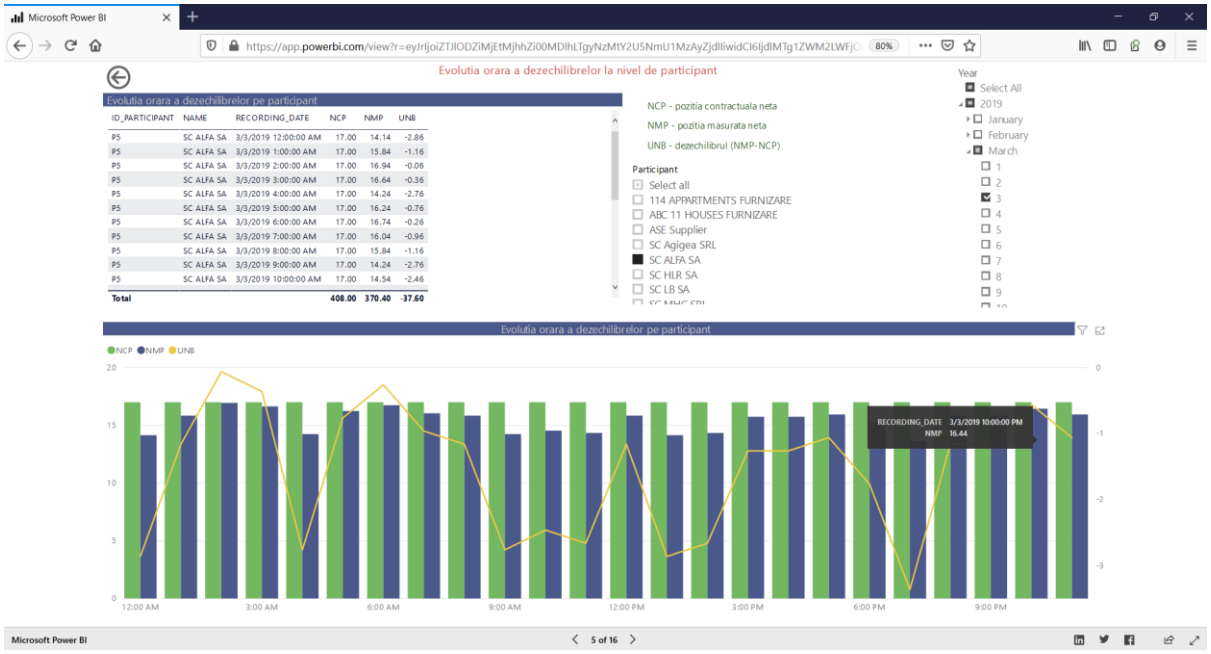

Fig. 4. Hourly evolution of imbalances at participant level

For the analysis of the revenues and hourly expenses of the BRP members resulting from the internal redistribution of the costs/revenues related to the imbalances, the reports were built that allow:

- view the evolution of surplus and deficit prices over a given period;
- the comparison of the prices on the balancing market with the adjusted prices applied at BRP level;
- analysis of the gain obtained by affiliation to the respective BRP.

The reports contain filters for selecting the period and the name of the BRP members, if a detailed analysis is desired. Fig. 5 shows the values of the imbalances for a certain selected period, at the BRP level.

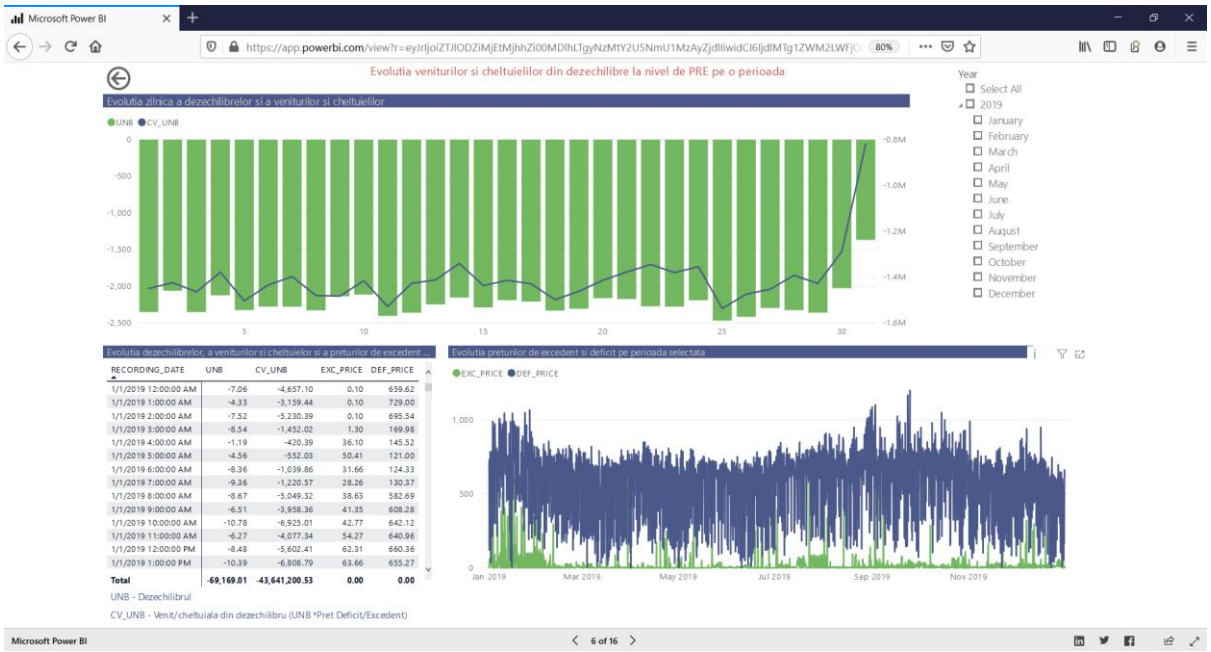

Fig. 5. Evolution of revenues and expenditures from imbalances at BRP level

Imbalance costs are obtained by applying the deficit/surplus price to the value of the imbalance. The evolution of revenues and expenditures from imbalances can be tracked at the BRP level and is displayed tabularly and graphically. To visualize the evolution of surplus and deficit prices, the report that compares the prices on the balancing market and the rectified prices to be applied at the BRP level can be used. Prices are displayed in hourly intervals depending on the month and day selected as parameters from the available filters (Fig. 6).

Fig. 6. The evolution of surplus and deficit prices

The distribution report of income and expenses from imbalances by participants (Fig. 7) allows the analysis of imbalances and gains obtained by a certain participant, for a certain period, as a result of affiliation to BRP. The participant and the period (year, month) are selected from the filters available at the report level.

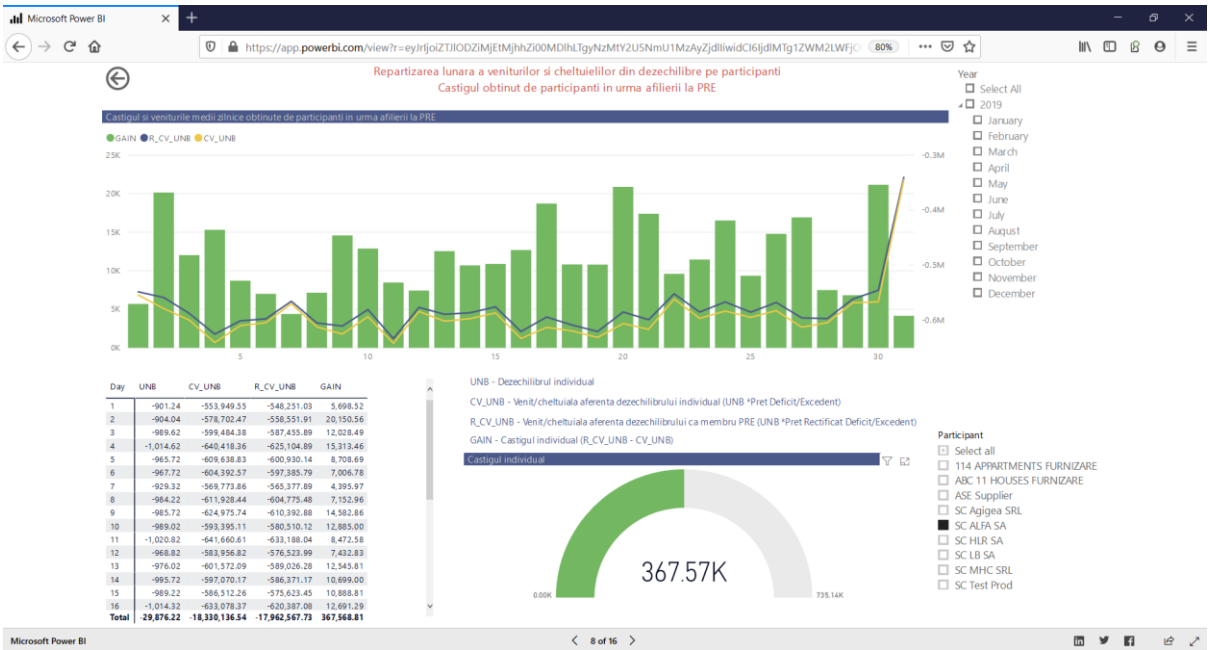

Fig. 7. Distribution of income and expenses from imbalances by participants

At the BRP level, it is possible to analyse the balancing expenditures and revenues by displaying the balancing expenditures and revenues obtained by the BRP at the level of a day, taking into account the sign of the power system. To select the period, select the month and day from the available filters (Fig. 8).

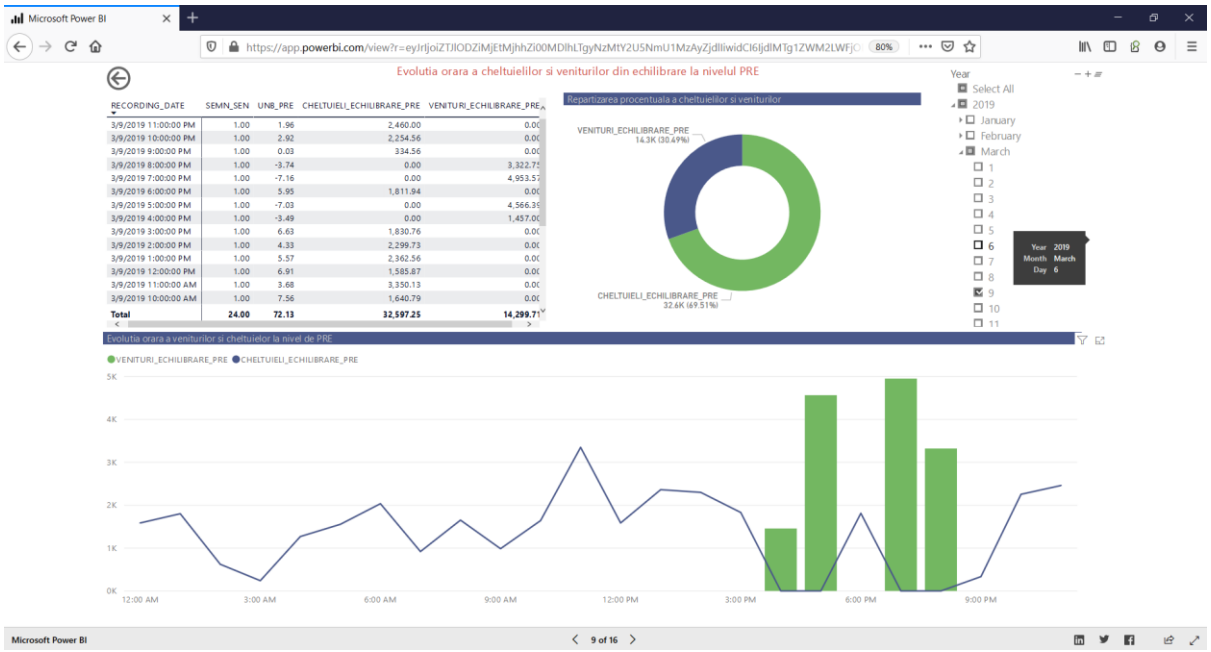

Fig. 8. The evolution in time of the balancing expenses and incomes at the BRP level

The display of the distribution of quotas for direct and indirect revenues and expenses related to imbalances at the level of BRP members for a certain selected period is presented in Fig. 9.

A filter is available to select the participant to display all participants and select them for analysis.

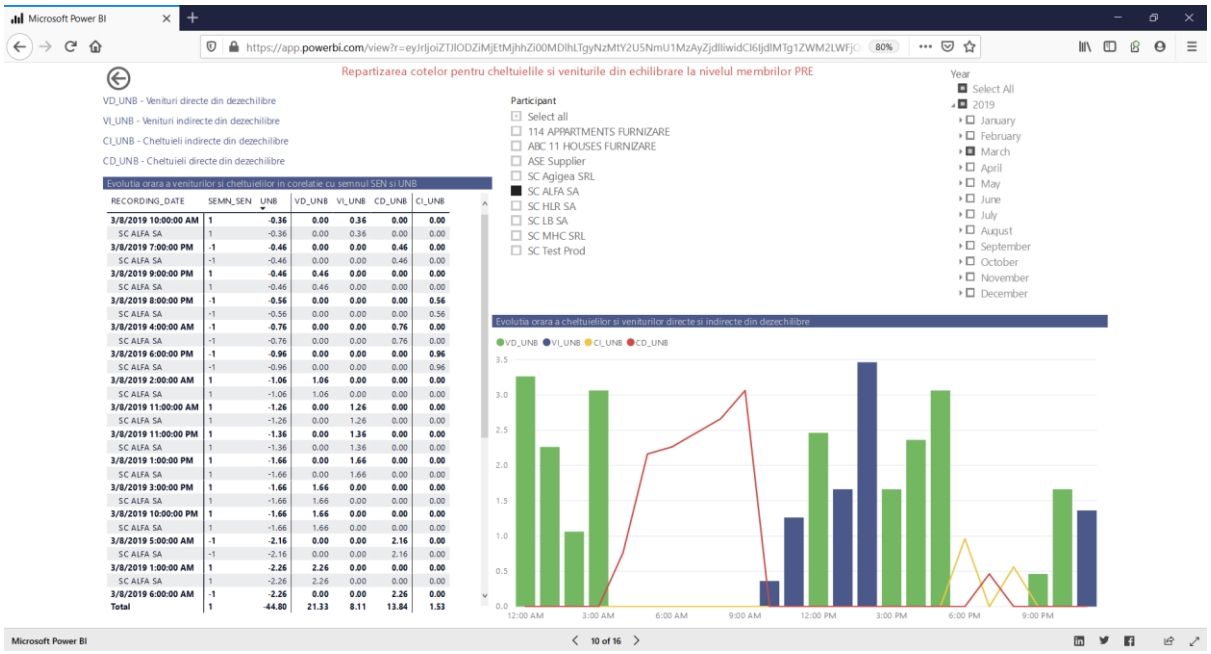

Fig. 9. Allocation of quotas for balancing expenses and income

For the analysis of balancing income and expenditure, reports are available in which the values are analysed at the level of BRP, over a certain period, and these amounts are distributed among members according to the quotas previously established. The evolution in time of the balancing expenses and incomes at the BRP level (Fig. 10) allows the analysis of the expenses, incomes and the corresponding net values at the BRP level for a certain selected period.

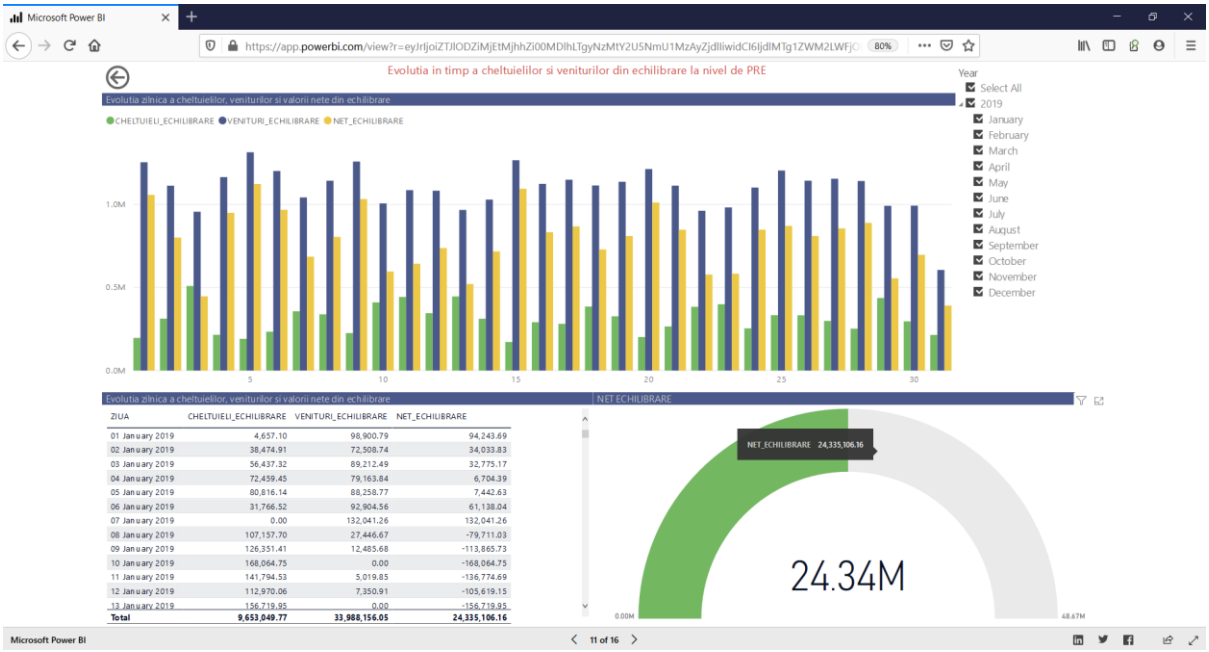

Fig. 10. The evolution in time of the balancing expenses and incomes at BRP level

The distribution of balancing expenses and revenues between BRP members is presented in Fig. 11. The allocation quotas and the corresponding percentages for a selected period are determined. The data are displayed tabular on each day and BRP member as well as graphically.

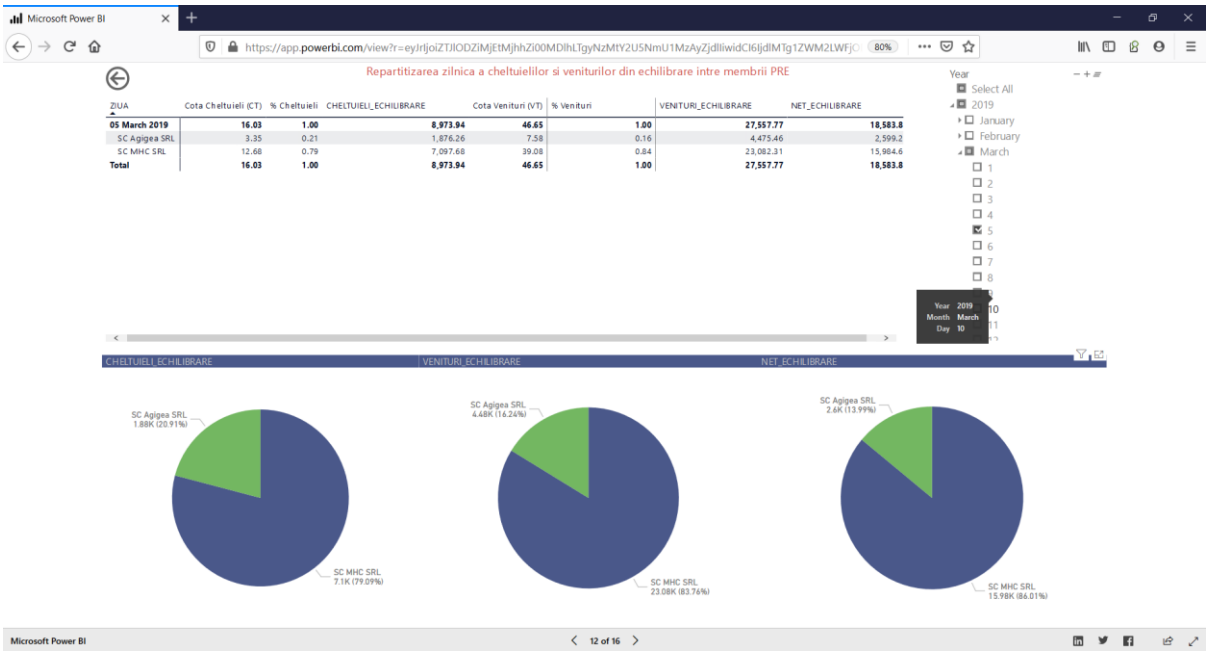

Fig. 11. Distribution of balancing expenses and revenues among BRP members

The evolution over time of the balancing expenses and incomes at the level of the BRP members (Fig. 12) allows the analysis of the incomes, expenses and the net value coming from the balancing of the system at the level of a selected participant. The analysis can be performed for a period of one month selected from the available filters. The data are viewed in tabular form, and the evolution of the indicators is displayed graphically.

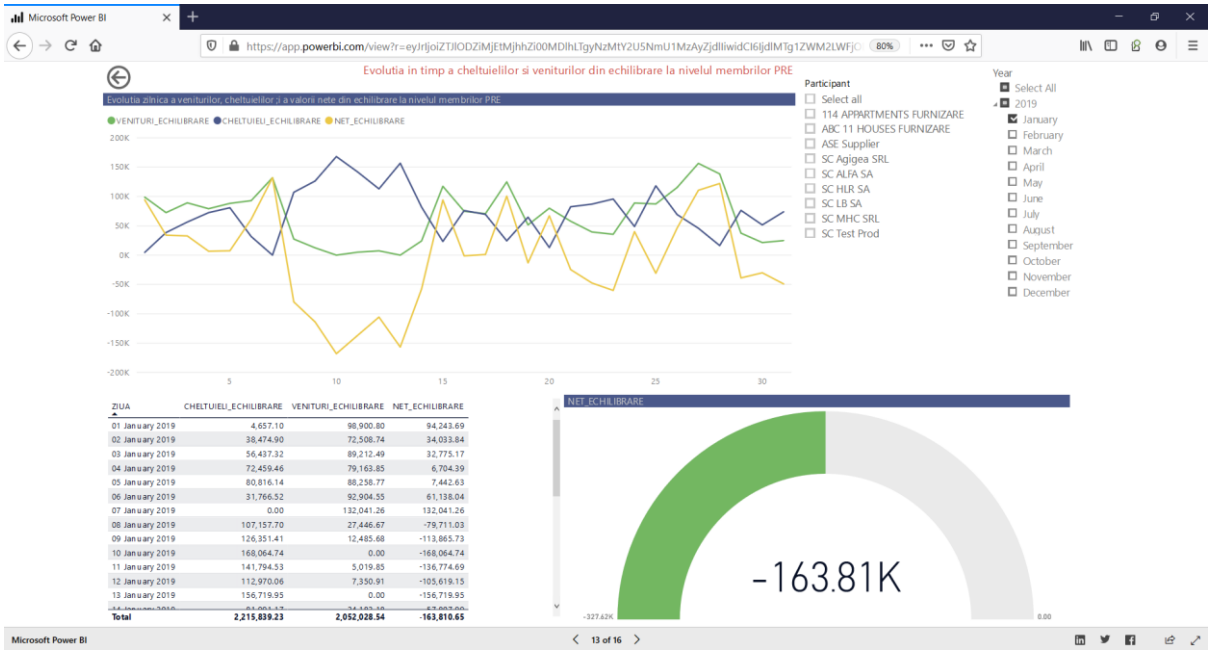

Fig. 12. The evolution in time of the balancing expenses and incomes at the level of the BRP members

It is possible to analyse the share of imbalances for each participant, as well as at the BRP level, for a selected period (Fig. 13).

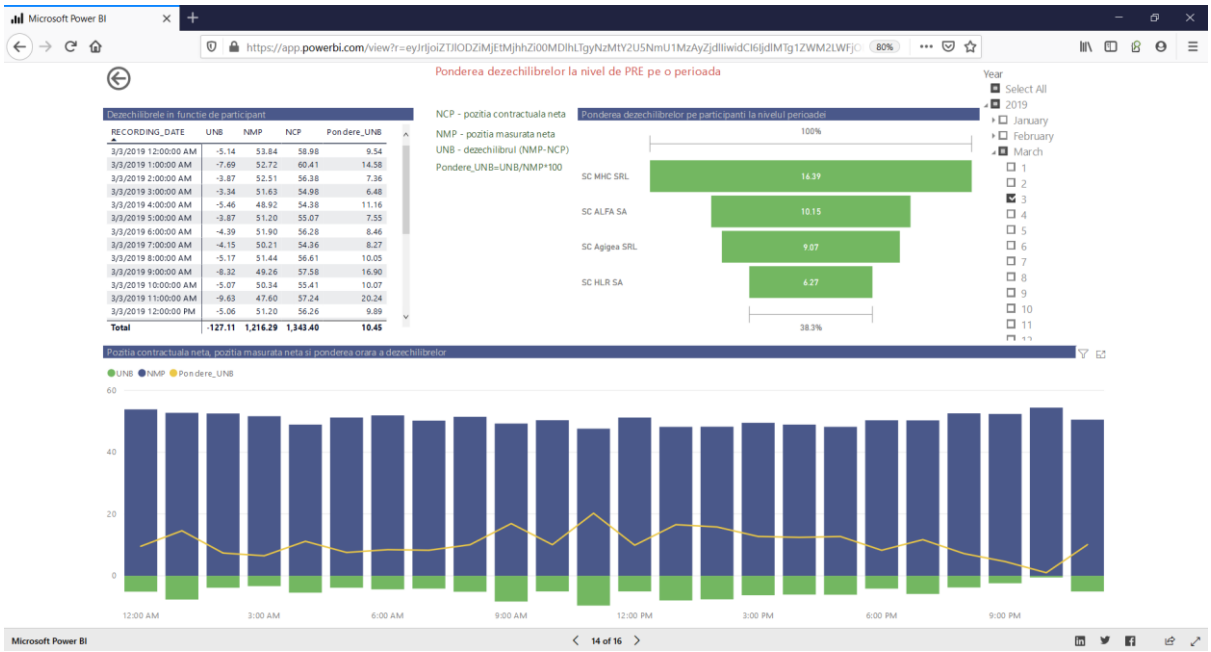

Fig. 13. The share of imbalances at the level of BRP over a certain period

For the analysis of the efficiency of BRP, the ratio between the average corrected price and the average market price for both deficit and surplus is determined.

The ratio between rectified prices and OPCOM (market operator) prices allows the analysis of these indicators over different periods of time, both tabular and graphical (Fig. 14).

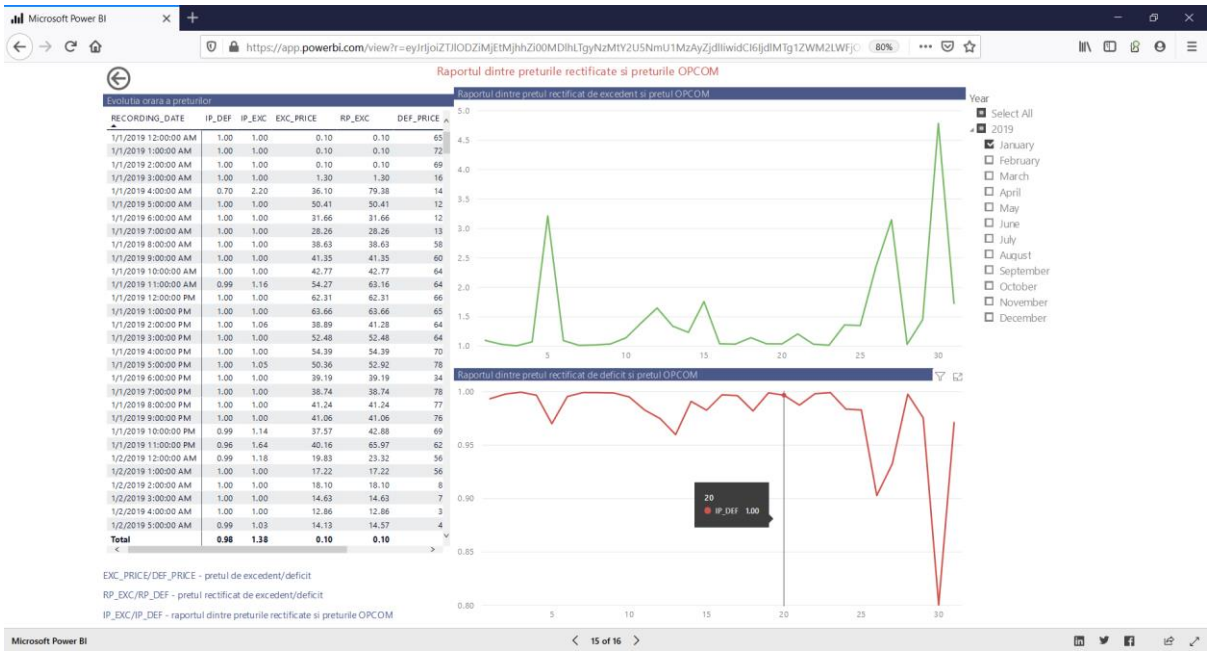

Fig. 14. The ratio between rectified prices and OPCOM prices

BRP efficiency is calculated as the difference between the average deficit/surplus price within the BRP and the average deficit/surplus price of OPCOM. The higher it is, the more significant the advantage of participating in a BRP. The difference between the rectified prices and the OPCOM prices (Fig. 15) can be made for different periods of time.

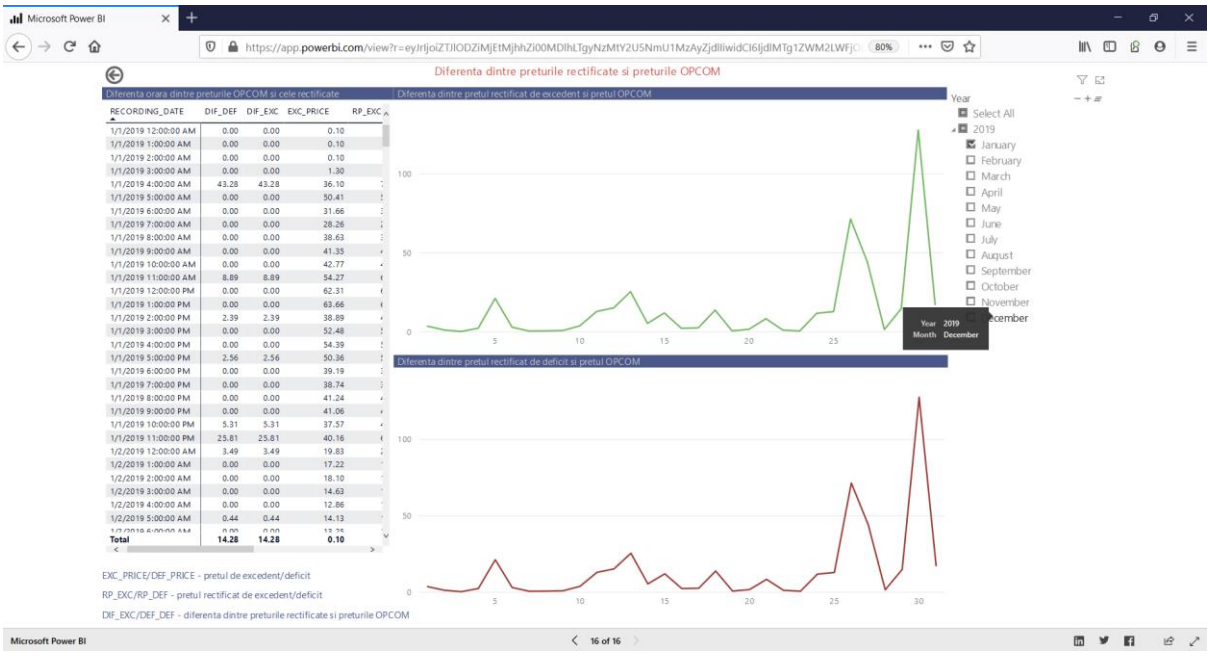

Fig. 15. The difference between rectified prices and OPCOM prices

The detailed reports made within the ABI-PRE module contain particularly useful information regarding the BRP activity. The reports allow the analysis and interpretation of the activity carried out at the level of each participant, as well as at the level of BRP. Among the editing facilities in the program can be mentioned: filters, types of graphs used to display the evolution of the various indicators followed, the possibilities of selection for analysis and statistical data processing. The dashboard for ABI-PRE module to access the reports is presented in Fig. 16.

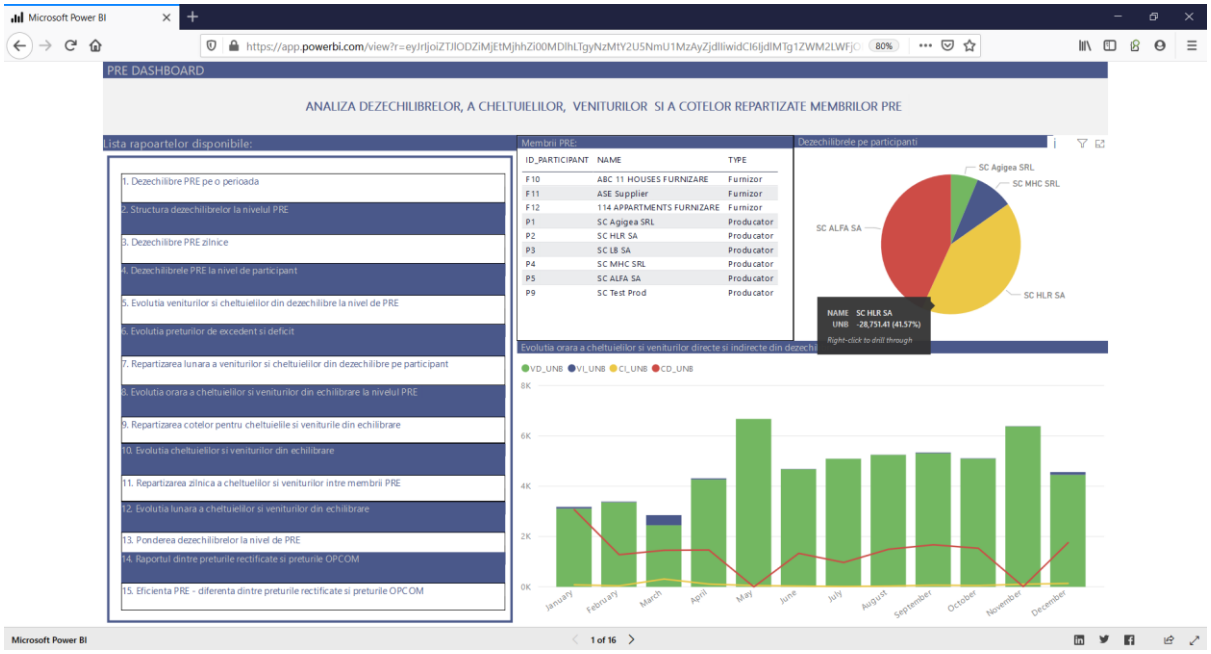

Fig. 16. Dashboard for ABI-PRE module

3 Conclusions

The purpose of the balancing market is to ensure the balance of the production/consumption balance of electricity in real time, using the resources offered in a competitive system. The European Union promotes the development of the balancing market at regional level and considers it useful to strengthen the regional cooperation of transmission and system operators. According to [6], regional cooperation should be compatible with the evolution towards a competitive and efficient internal electricity market. ENTSO for Electricity promotes cooperation between TSOs at regional level, ensuring interoperability, communication and monitoring of regional performance. The regional coordination centres complement the role of transmission and system operators, by fulfilling the attributions of regional interest. The correlation of the way of determining the imbalances with the transactions in the balancing market is in line with the European trends necessary for the creation of the internal energy market. Each BRP assumes financial responsibility towards the TSO for the settlement of the total imbalances resulting from the aggregation of the individual imbalances of each participant that has registered in that BRP. Bringing together several participants within the same BRP determines the mutual compensation of individual imbalances and the efficient distribution of costs, but also of benefits.

The software platform developed by the authors of this paper is equipped with a module specialized in analysing imbalances at the BRP level (ABI-PRE) and provides support in determining specific indicators for the entire BRP, but also in terms of the

contribution of each participant (BRP member).

The paper describes the allocation between the members of a BRP of the costs/revenues generated by the net imbalances of the respective BRP and the calculation methodology implemented within the prototype. The reports made within the ABI-PRE module are generated following the analysis of the specific and performance indicators of the BRP.

4 Acknowledgment

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References

[1] Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing, EBGL 2017

[2] A.N.R.E., Rules for transparency of settlement within the parties responsible for balancing, A.N.R.E.'s Order 76/2017, Bucharest, Romania, 2017

[3] Terms and conditions for the parties responsible for balancing, CNTEE Transelectrica, 2018

[4] A.N.R.E., Regulation on the operation and settlement of the balancing market and the Regulation on the calculation and settlement of imbalances of the parties responsible for balancing and for amending, supplementing and repealing provisions in the electricity sector, Annex no.1 - Regulation for the operation and settlement of the balancing market, Annex no. 2 - Regulation for the calculation and settlement of imbalances of the parties responsible for balancing, A.N.R.E.'s Order 31/2018, Bucharest, Romania, 2018

[5] Module for the analysis of imbalances at the level of a BRP (ABI-PRE) developed as a prototype under the Contract: 62/2016, Bucharest University of Economic Studies, http://smartrade.ase.ro/obiective

[6] Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity, 2019

PhD. Lecturer Simona-Vasilica OPREA (b. July 14, 1978) teaches Databases, Database Management Systems and Software Packages at the Faculty of Economic Cybernetics, Statistics and Informatics of the Bucharest University of Economic Studies. She received the MSc degree through the Infrastructure Management Program from Yokohama National University, Japan, in 2007, the first Ph.D. degree in Power System Engineering from the Bucharest Polytechnic University in 2009, and the second Ph.D. degree in Economic Informatics from the Bucharest University of Economic Studies in 2017. She is involved in several national and H2020 European research projects as member or project manager. She is currently project director for a H2020 project entitled Multi-layer aggregator solutions to facilitate optimum demand response and grid flexibility (acronym SMART-MLA). In the research projects, she has contributed to the development of data frameworks, data analytics, modelling and informatics prototypes architectures. Her scientific fields of

interest include Databases, Database Management Systems, Programming, Information Systems, Data Science and Data Analytics.

PhD. Professor Adela BÂRA (b. October 11, 1978) is director of the Data Science Excellence Center in the Bucharest University of Economic Studies. She is the author of 19 books in the domain of economic informatics, over 60 published scientific papers and articles (among which over 20 articles are indexed by Web of Science). She participated in 10 research projects (4 of them as principal investigator or project responsible), financed from national and international research programs. Domains of competence include Databases (relational, object-oriented, spatial, NoSQL); data warehousing; Big Data; data mining; Artificial Neural Networks; Machine Learning; IoT; Business Intelligence; Informatics solutions for energy systems (data integration, analytics, web-services, cloud-computing development).

MSc Ciprian Georgian DRAGOMIR (b. May 27, 1977) graduated Petroleum-Gas University of Ploiești, București in 2003. Since 2017, he works for CEZ Romania, a Distribution System Operator (DSO) in Romania. His main activities are related to: ensuring the good management of labour relations; promoting an efficient dialogue in relations with trade unions/employee representatives to establish a solid platform for communication, negotiation and application of collective labour agreements; organizing and executing activities related to the observance and improvement of labour relations, mainly by participating in the elaboration/negotiation of collective labour agreements, elaboration/updating of the provisions of internal regulations and order and functioning regulations; and monitoring the application of legislation in the field of labour relations.

PhD. Osman Bülent TÖR received the B.S., M.S. and Ph.D. degrees from Middle East Technical University (METU), Turkey, in 1998, 2001 and 2008, respectively. He has almost 20 years working experience in the electrical power sector. At this moment, he is working as Managing Partner and Director for EPRA. Prior to this position he was leading the Power Systems Analysis and Planning Department of TÜBİTAK-Ankara, as a chief power system R&D engineer for 12 years, before he left TÜBİTAK and joined to EPRA in 2013.

PhD. candidate Ștefan PREDA (b. October 9, 1969) graduated the Faculty of Economic Cybernetics, Statistics and Informatics, with a bachelor's degree in Economic Informatics in 2013. In 2015, he received his master's degree from the same faculty of the Bucharest University of Economic Studies, skilled in Databases Support for Business. Currently he is working with Oracle Corporation as Principal Technical Support Engineer, software analyst, in Fusion Middleware, EMEA Identity Management team. He is attending doctoral studies, since 2017 in economic informatics researching renewable energy systems integration from data, optimization and efficient operation point of view.