

THE CURRENT STATE OF THE ELECTRICITY MARKET AND SYSTEM SERVICES IN ROMANIA

Emil DIACONU

Valahia University of Targoviste, 13 Aleea Sinaia Street, 130004 Targoviste, Romania

Corresponding author email: emy_diaconu@yahoo.com

Abstract

The subject dealt with in this paper is a sensitive one due to the energy crisis whose presence is already felt and which will certainly deepen with the approach of the cold season. The current work represents only the first part of a study related to the analysis of the current state of the energy market and system services and will be continued with a second work that will propose a solution in cogeneration to counterbalance the system problems we are facing. Thus, the subject discussed is not that of energy production for domestic and industrial consumers, but that of the production necessary for the optimal functioning of the National Energy System (NES). Of course, from the point of view of the environmental protection all the electrical energy, even that required for system services, should be 100% produced from renewable energy.

Key words: balancing market, environmental protection, National Energy System, renewable energy, sources system services.

INTRODUCTION

The rapid pace of growth of the global economy, the technological advance and the demographic growth made the demand for energy to be higher and higher. This demand could be met by the use of fossil fuels which have come hand in hand with global warming, the greenhouse effect and climate change (Popescu et al., 2018). Also, the lack of these energy sources all over the world, the dependence on foreign resources and their fluctuating price lead to an ever-increasing interest in renewable energy resources and their study. (Kulcu & Cihanalp, 2017).

Almost 35% of electricity consumption in our country is provided by coal and gas plants (EGR, 2019). A considerable share of electricity production is achieved by production capacities that are nearing the end of their life. Some of these are already economically inefficient and too polluting, requiring renewal through retrofitting or replacement.

The lack of investment caused mainly by a deficient and unpredictable legislation has made Romania move from a traditional position of an exporting electricity producer to a position of an energy importer, reaching record imports of over 2000 MW per hour.

The increase in the production of energy from renewable sources, as a result of numerous wind and photovoltaic farms starting commercial

operation, has led to the need to increase the amount of electricity for balancing, to cover the significant differences between the production and consumption of electricity.

THE CURRENT STATE OF THE NATIONAL ENERGY SECTOR

The main electricity production companies in Romania are owned by the state. These are the Cernavodă nuclear power plant, operated by Nuclearelectrica, hydroelectric plants operated by Hidroelectrica and around 20 thermal plants that use coal.

The structure of the energy sector and its expected evolution until 2030 indicate that the achievement of the strategic objectives defined by the Energy Strategy of Romania for the period 2019-2030 (EGR, 2019) depends on the success of strategic intervention in several key areas of the energy industry, especially in terms of renewal, retrofitting or replacing outdated electricity production capacities.

The main resources of electricity production from primary sources are coal and hydrological resources. Together they have a contribution of almost 50% in electricity generation. They are followed by nuclear, gas and wind power generation.

In the year 2021, the structure by types of resources of electricity delivered to the grid by

producers with dispatchable units is presented in Figure 1 (ANRE, 2021).

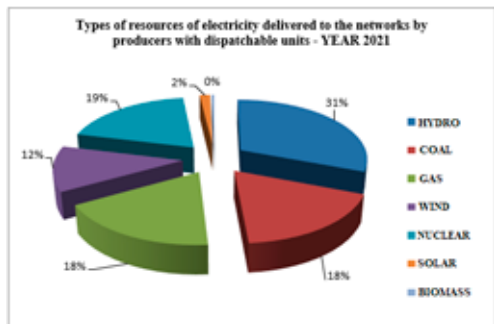


Figure 1. Production by types of resources in 2021

Currently, installed capacity by technology types and production structure by resource types are shown in Table 1 respectively Figure 2 (ANRE, 2021).

Table 1. Installed capacity by technology types

Present installed capacity	MWh
Hydro	6643
Coal	3092
Hydrocarbons	2623
Wind	3003
Nuclear	1413
Solar	1388
Biomass	107
Others	4
Total	18273

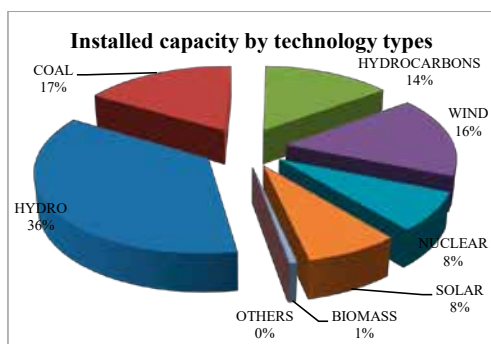


Figure 2. Production structure by types of resources

From the comparative analysis of the above data, a small variation of electricity production by types of resources can be observed. If 15

years ago Romania had a traditional position on the European energy market as an exporter of electricity, given the excellent hydrological conditions and the production of wind electricity, today Romania has reached record imports to cover a consumption of over 2000 MW per hour.

In 2019, 27.93% of the total energy was produced in hydropower plants, in 2020 was 29.01%, and in 2021, 30.85%. Moreover, hydropower capacities have had and still have a substantial contribution to the system services market. Equally important is the fact that large hydropower plants were built between 1960-1990, requiring investment in modernization and/or retrofitting.

It is expected that there will be restrictions and impositions on hydropower to protect the environment, which will lead to a decrease in hydropower production. Given that the most favourable locations in terms of hydropower have already been used, new projects will only be developed to provide benefits other than energy and will require state participation in securing financing.

Coal-fired power plants produced 22.77% in 2019, 16.55% in 2020 and 17.99% in 2021 of the total generated electrical energy. Currently, coal-based capacities play an important role in ensuring system stability (providing system services). By 2026, coal-fired power producers will have to retrofit or replace equipment or lose their environmental permits.

In the long term, the role of lignite (Matei et al., 2010) in the energy mix can be preserved by developing new capacities, which must be equipped with CO₂ capture, transport and storage technologies.

Pit coal reserves are impossible to exploit in terms of economic efficiency, which makes the construction of new groups based on coal unlikely.

Of the country's total electricity production, the nuclear power plant produced 19.29% in 2019 and 20.78% in 2020. The two reactors with a total installed capacity of 1413 MW (2x706.5 MW) require upgrades. The first reactor is expected to be shut down between 2026-2028.

Currently, Nuclearelectrica and the American company NuScal have announced the construction of the first small modular reactor (SMR) in Romania, which will be installed at the

former thermal power plant in Doicești, in Dâmbovița County. The NuScale power plant is equipped with 6 modules, having an electric power of 462 MWe and will contribute to the reduction of CO₂ emissions by 4 million tons of CO₂ emissions/year.

Thus, Romania becomes one of the first countries in the world, and the first in Europe, to implement the innovative and safe technology of small modular reactors (SMR) - NuScale, which enable the supply of "clean" energy.

In 2019 gas plants provided 15.88%, in 2020, 18.17% and in 2021 17.99% of the total energy produced. By 2025, the old gas-fired power plants, with more than 2500 MW installed, will require replacement.

Romania has set a strategic objective to rely on the new gas cogeneration units (gas turbines and gas engines) which can balance the unpredictable SRE production. This fact is due to the flexibility of the new cogeneration technologies.

Exploitation of the gas resources found in the Black Sea will make a major contribution to ensuring Romania's energy security. Onshore and offshore natural gas production may have the potential to exceed the current estimated level of domestic demand.

In 2019 wind energy represented 12.44% and in 2020 represented 13.63% of the total energy produced. Romania aims to remain an attractive destination for new RES investments in the long term. A gradual increase in wind power capacity by 1300 MW and photovoltaic power by 1700 MW is estimated. However, the maximum installed power in wind energy has already been reached (3000 MW). For any additional 300 MW installed in wind power, 100 MW of storage capacity is required.

The wholesale electricity market represents the framework in which electricity is purchased by suppliers from producers or other suppliers for resale or own consumption, as well as by grid operators to cover their own technological consumption.

Transactions between participants in the wholesale electricity market must be concluded only by participating in one of the centralized markets organized by the electricity market operator, Opcom SA (OPCOM, 2022).

On the Next Day Market (NDM) (Transelectrica, 2022) there are firm electricity

transactions made every day for each time interval for the next day delivery, based on the offers submitted by NDM participants. OPCOM S.A. is the counterparty for all executed purchase/sale transactions (Table 2).

Table 2. Average NDM prices

Year	Average NDM prices (Ron/MWh)		
	201	2020	2021
weighted average price	251.21	296.37	1173.64
arithmetic average price	238.80	284.32	1139.30
maximum peak price	272.87	354.82	1424.15
average price outside the peak	204.75	213.82	854.45

In the bilateral contract market (PCB) (OPCOM, 2022), contracts for the sale and purchase of electricity are concluded for a fixed period of time (Table 3).

Table 3. Average PCB prices

Year	Average PCB prices (Ron/MWh)		
	2019	2020	2021
PCCB-LE-FLEX	289.54	262.91	323.24
PCCB-NC	277.69	264.28	367.83
PC-OTC	269.41	265.61	434.45

The Intraday market (IM) (OPCOM, 2022) was created in order to adjust the portfolio of contracts to production possibilities, consumption needs and cross-border transactions and to reduce possible imbalances. Participants can send purchase/sale offers after the transactions on NDM have been carried out and they are carried out at the beginning of the electricity delivery time - during the day of delivery, no more than 1 hour before delivery. OPCOM is the counterparty for all executed purchase/sale transactions.

SYSTEM SERVICES (SS)

The system services market (Transelectrica, 2022) was organized to maintain the operational safety of the national energy system and the quality of the transported electricity (Andrei et al., 2019). System services are provided by producers or end customers (ANRE, 2021) who provide services at the request of the transport system operator (TSO) in order to maintain the level of safety in operation of the NES, as well as the quality of the electricity transported to the parameters provided for by the rules in force. By procuring the balancing capacity, the TSO has the possibility to activate an electricity

production facility, on demand, for balancing the SEN in real time (TEL 04.05, 2022; ANRE, 2007; ANRE, 2011) the following categories of auxiliary services:

- **Secondary reserve:** the required power reserve, when the frequency and/or NES balance deviates from a certain value, and production capacities can be mobilized (started), automatically in a maximum of 15 minutes - becoming Automatic Frequency Recovery Reserve (minimum 1 MW, start-up time up to 30 seconds and time to reach nominal power - 7.5 minutes);
- **Fast tertiary reserve:** the energy reserve provided by generation groups that are qualified to charge in a maximum of 15 minutes (power generating units that can be switched on / off) - becoming the manual frequency recovery reserve (minimum 1 MW, start-up time up to 2.5 minutes and time to reach rated power of 12.5 minutes). In 2019, the weighted average price for the fast tertiary reserve was - 48.47 Ron / MWh). In 2020 the weighted average price for the rapidly increasing tertiary reserve was - 45.21 Ron/MWh, and the weighted average price for the rapidly decreasing tertiary reserve was - 17.20 Ron/MWh).
- **Slow tertiary reserves:** energy reserve provided by generating groups that have start-up and load times of less than 7 hours (generation units that can be switched on / off) - becoming replacement reserve (minimum 1 MW, activation time /start up to 30 minutes and full activation time – 30 minutes).

The average amounts of energy contracted by Transelectrica for system services (hMW) in 2020 are presented in Figure 3 (Transelectrica, 2020).

To participate in the auctions, system service providers must operate dispatchable units technically qualified by CNTEE Transelectrica SA, register as market participants and register as part of a balancing responsible party (BRP). Registration as a participant in auctions is done immediately after signing the framework contract for the sale/purchase of system services.

Auctions for purchasing system services are held daily. The required quantities of system services will be auctioned for each reserve

category and for each time slot of the respective period.

The closing price of the auction for each time interval of the purchase period is established by order of merit, registering all price-quantity pairs from the lowest price to the highest, until the required quantity is covered. The price of the last winning bid is the price at which all quantities in the winning bids are contracted. For each offer, an addendum is signed as part of the contract for the provided system services. System services are considered to be provided/performed if the system service providers offer the reserved energy on the Balancing Market.

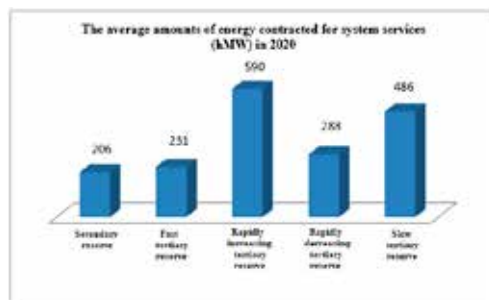


Figure 3. The average amounts of energy contracted for systems services (hMW) in 2020

THE BALANCING MARKET

The balancing market (BM) (Transelectrica, 2022) is the centralized market organized and managed by the transmission system operator (CNTEE Transelectrica SA) for the real-time balancing between electricity production and consumption and to ensure the safety and stability in operation of the National Energy System (NES) and to resolve grid congestions. Bids in the balancing market are made several hours before the day the energy delivery starts, being the place of "last resort" where the final adjustment of the scheduled electricity deliveries could be made before the real-time delivery of the energy.

System service providers must offer on the balancing market:

- according to the regulations regarding the increase regulation - the available electrical power that can be increased/used to cover the production deficit/consumption surplus;

- according to the regulation on the downward adjustment - reduction of production to compensate for the production surplus/consumption deficit.

The winning price for each time slot is the price of the last winning bid (the highest price of the quantity-price bids, ordered in ascending order of merit) and is the price at which all quantities of the winning bids are contracted for upscaling and vice versa for downscaling .

Participants in the electricity markets must choose a BRP. It manages the imbalances of all participants and tries to reduce these imbalances, distributing to its own participants the amounts and financial costs of the imbalances within the BRP.

For negative imbalances (deficit), they have to pay the settlement price resulting from the increasing bids accepted on the Balancing Market (BM), while for positive (surplus) imbalances they realize and for which they pay the settlement price resulting from the bids discount accepted on the Balancing Market (BM).

From February 2021, balancing market settlements are made every 15 minutes, which impacts the amount of energy delivered by system service producers and the prices paid by BM participants. Positive and negative imbalances, according to the new regulations, can be settled either at a single price, or at a positive price for negative imbalances or at a negative price for positive imbalances, depending on the closing price of the BM on each interval. All these measures have been taken to better manage imbalances – reducing them and has substantial negative impact for those who do not manage imbalances effectively.

The integration of the Romanian electricity market into the European market is one of Romania's strategic objectives. Starting from 2014, the Romanian NDM operates in a coupled system with the NDM markets in the Czech Republic, Slovakia and Hungary.

Since the end of 2019, the romanian IDM has been operating together with 20 other EU member states.

All transmission operators in Europe, including Tranelectrica (member of the European Network of Transmission System Operators for Electricity - ENTSO-E), are working to

establish the European platform for balancing energy exchanges (PICASSO, MARI) (PICASSO, 2022; MARI, 2022) to be fully operational by the end of 2022.

CONCLUSIONS

This paper presents the current situation of the National Energy System (NES) and the current conditions on the energy market.

Considering the current situation of NES, the author will list on the one hand some of the problems it faces and on the other hand opportunities. The oportunities listed below favor the development of a cogeneration power plant project needed to provide system services, project that will be presented in a future paper which will constitute the continuation of this work and, at the same time, the end of the study. Among the current problems faced by NES it can be mentioned:

- a considerable share of electricity production is made by production capacities that are nearing the end of their life;
- increase in the production of energy from renewable sources (Nedelcu et al., 2019; Dragomir et al., 2016), as a result of numerous wind and photovoltaic farms starting commercial operation, has led to the need to increase the amount of electricity for balancing, to cover the significant differences between the production and consumption of electricity;
- the lack of investments caused mainly by a deficient and unpredictable legislation, made Romania move from a traditional position of electricity producer that exports, to a position of energy importer, reaching record imports of over 2000 MW per hour.

To counterbalance the existence of the energy problems we are facing, it is also mentioned some opportunities that could solve some of them and that will be discussed in a feature paper:

- Expansion of electricity markets at European level;
- By the end of 2022, the European platform for balancing energy exchange (PICASSO, MARI) is expected to be fully operational; as a result, all existing manufacturers wishing to participate in the European

balancing market will go through a new qualification process.

- The European directions for the development of the energy markets - transposed in the Directives, provide for the expansion of the use of cogeneration, especially of capacities up to 20 MW as a measure to increase energy efficiency and promote the distributed production of electricity.

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