ROMANIA'S ENERGETIC SYSTEM

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ABSTRACT

Through this paper, the authors are proposing to offer a global image of the current state of Romania's energy sector, with emphasize on the energy production and the targets that are desired to be reached in this field, in the future. Other concepts will be taken into consideration, such as: the energy demand analysis on different branches, the structure analysis of the primary energy mix, the consumption, production and its composition in Romania in the year 2016, the energy production mix composition on a regular day in the year 2017.

KEYWORDS: *energetic system, production mix, energetic objectives*

INTRODUCTION

The problems with Romania's energy system started to appear in 1882, when the first two power stations were put to use in Bucharest, providing the necessary energy for the Cotroceni Palace and the Regal Palace on Victory Road. [1]

Around the 1900's some hydroelectric power plants were put in use, the energetic system has been evolving ever since.

As shown in a report done by the Citigroup in 2014[2], Romania is a medium sized market, with almost 20GW capacities installed, placed on the second place on a market sizes scale in Central and Eastern Europe. Although the energy demand in Romania is mainly based on the industrial players, the average consumption level per capita was lower in 2014 than half of the European average.

During 1990, the production, transport and electricity distribution was held by the public company RENEL[3]. After the successive restructuring in the year 1998, the company was divided into:

- CONEL- national electricity company
- Nuclearelectrica- nuclear energy supply company
- RAAN- Autonomous Municipal for Nuclear Activities

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Subsequently, in the year 2000, CONEL[2] was split in four different companies, each one with certain responsibilities:

- Termoelectrica S.A. – fossil fuel supply company
- Hidroelectrica S.A.- hydro energy supply company
- Electrica S.A. – distribution company, with eight subsidiaries for distribution and supply
- Transelectrica S.A.- transport company

The electricity distribution system in Romania is made of around 375.000 km of distribution network that ties together more than 9 million customers. The network is operated by eight licensed distribution companies, three of them being part of Enel, three of Electrica, one of CEZ and one of E.ON.

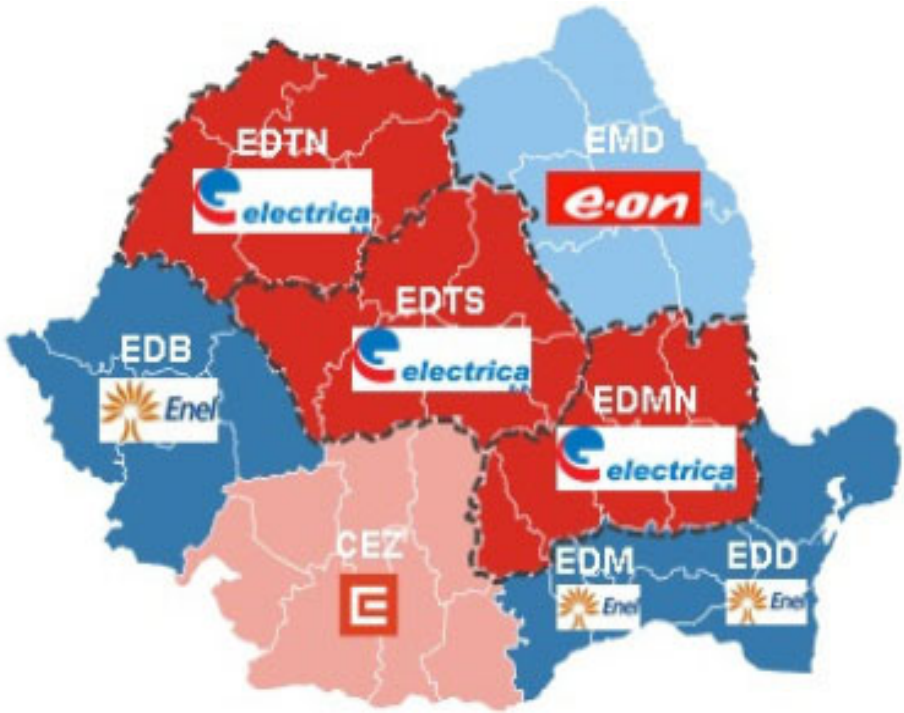

Figure 1. The energy distribution map (Source: Electrica)

From a legislative point of view, ever since 2007, the liberalization of the gas market in Romania has started, all the consumers being eligible to change their natural gas supplier. Although the liberalization of the gas market was officially made, the natural gas provision to the final consumers in a regulated regime continued. In the present days, according to the Electricity and Natural Gases Law (Law no. 123/2012), any natural gases consumer who exercised his right to eligibility has no right to go back to a regulated market. [4]

In general, the consumers on the competitive market are the industrial ones and the producers of electricity whom benefited after the market liberalization through obtaining a

lower price on natural gases than the one present on the regulated market. This regulated market represents 45.8% of the annual natural gases consumption, the growth rate of the consumers whom exercised their right of eligibility being very low.

Within Romania's Energetic Strategy, presented in the beginning of 2017 [4], the Ministry of Environment shows the evolution of the natural gases market liberalization process in Romania, aiming towards the natural gases quantity that was supplied to the final consumers on the regulated market as a part of the total consumption, and also on the total number of final consumers that exercised their right to eligibility (changed the supplier).

EXPERIMENTAL WORK

Regarding its contents, this paper shows aspects linked to the current situation of Romania's energetic system and the EU objectives regarding the electric energy in Romania's region.

In order to present Romania's current state, the country's Energy Strategy has been analyzed. The analysis had been completed with data interpreted and taken from the official Transelectrica website, from which the consumption, production and the production's components were determined, both on a regular day in the year 2017 and also for the full year of 2016. For this analysis, we selected each last day of each month, comparing the data that had been registered between 1 p.m. and 2 p.m. The data had been shown in Table 2 and Figure 4.

This study is limited to the data provided by the Ministry of Environment through their official websites, the bibliographic online sources being the only relevant ones at the moment, for this field.

RESULTS AND DISSCUSIONS

Electricity Consumption

According to the Romania's Energy Strategy, throughout the years, the electricity consumption fluctuated in the country, the registered values being between 40 TWh and 60 TWh. If between the years 2008 and 2009 the economic crisis determined a decrease of the electricity consumption, it gradually returned to 47.5 TWh in 2015, in 2016 the values being close to the ones registered the year before.

Although in the year 2015 Romania was ranked 6th with the lowest average price for the electricity for household consumption in the European Union (Eurostat), the purchasing power is relatively low, which means that the price is becoming a huge problem, making us have an elevated level of energy poverty. The households prefer using gas as an energetic resource, since its price per kWh is three times lower than the electricity one.

The electricity consumption needs to be looked at from an electromobility's point of view, meaning the public transport electricity usage -which decreased in the last year- or at the electric vehicles acquisition, whose price is still high.

Romania's gross consumption suffered a considerable decrease between the years 1990-2015, reaching 377 TWh in 2015[4]. The Romania's Energetic Strategy shows that

following the modeling of The Optimum Script, in 2030 the gross consumption will reach 394 TWh (a 4% increase), while the final energy demand will have a value of 269 TWh (a 6% increase). The same modeling of the script provides, however, for the year 2050, a decrease of 7% for the demand of primary energy comparing the year 2030 (from 394 TWh to 365 TWh).

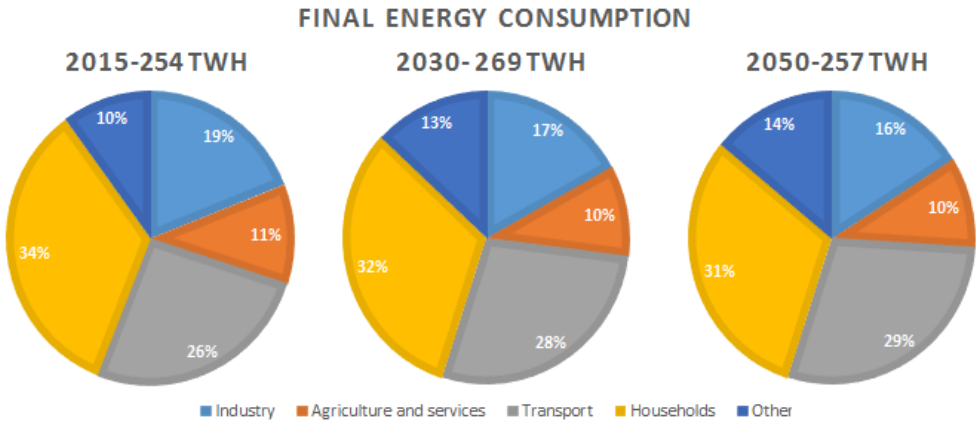

Figure 2. The final energy demand on each activity branch, during 2015-2050 (%)

According to the data shown in the Romania's Energetic Strategy and the ones presented in the Figure 2, we can observe the following:

- The households sector remains the biggest, judging by the consumption of final energy, although it registers a decrease of 2% in the year 2030 compared to 2015 and one of 3% in 2050 compared to 2015.
- The smallest sector, judging by the consumption of final energy, remains the agriculture and services one, sector that in 2015 used 11% out of the final energy, while in 2030 and 2050 it decreased to 10%.
- The transports sector is estimated to increase from 26% in 2015 to 29% in 2050.
- The other industrial sectors are also having an estimated increase of the final energy usage by 4% from 2015 to 2050.

The Energy Mix

Regarding the structure of Romania's energy mix, we can observe that, according to the data provided by Romania's Energy Strategy between the years 2016-2030, the fact that in 2015 the highest ratio in the mix belonged to natural gases -29% (111 TWh), closely followed by petroleum- 26% (100 TWh). The renewable energy has 19% of the mix (72 TWh), while coal has 17% (65 TWh). The smallest ratio belongs to nuclear energy -9% (34 TWh), caused by the inefficiency of the Uranium resources exploitation, respectively the closing of the Uranium mines. The difference between the gross consumption of energy and the primary energy mix is represented by the net export of electricity (6 TWh).

The desired composition for the energy mix by the year 2030 states especially changes regarding the increase by 8% of nuclear energy (from 9% to 17%), the increase of

renewable energy by 3% (from 19% to 22%), maintaining at the same levels of petroleum consumption, the decrease of the coal consumption with 7% (down to 10%), respectively the decrease with 3% of natural gases consumption (down to 26%).

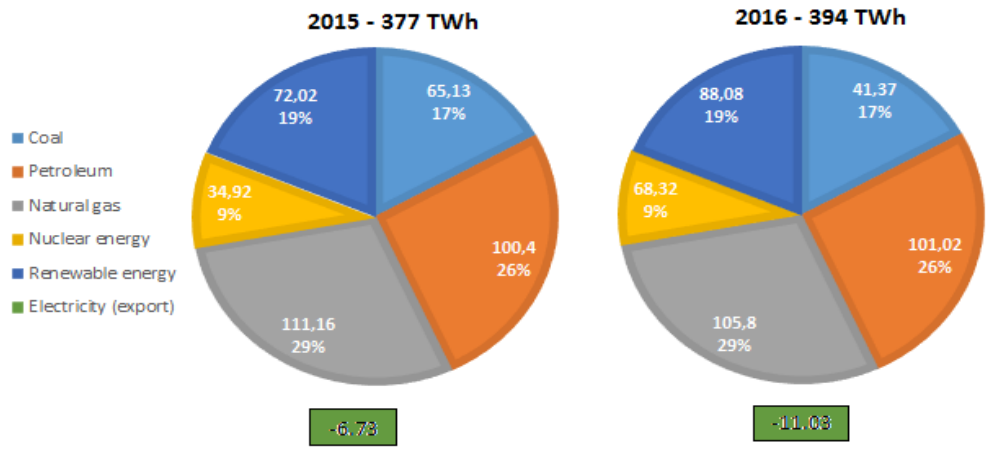

Figure 3. The structure of the primary energy mix in 2015 and 2030 (Source: PRIMES)

Following the simulation of different scenarios, information regarding the better usage of primary energy resources came up.

If we're talking about petroleum, we can say that the decrease of the oil price in the last years, as well as the investments that need to be done in this field, will lead to a cutting in half of the internal production of petroleum, reaching 2 mil tons in 2030.

The results of the natural gases production modeling are different, at least regarding the price evolution, the production depending a lot on the developing of the recently discovered supplies in the Black Sea. It is although expected that until the year 2030 the maximum level of the production of natural gases coming from the Black Sea will be reached. [6]

The situation regarding the production of brown and hard coal depends a lot on the national raw material demand, and also on the competitiveness of the raw material's price. Although for the years between 2017 and 2023 the closing of 5 coal quarries are being foreseen, until the year 2030, 15 quarries will be maintained opened and active.

The evolution of biomass is being watched with great interest, since the usage of firewood remains an important representation of the biomass used for energetic purposes. Despite all this, until the year 2030, a decrease by 20% of the usage of firewood is being foreseen, but also an increase of the potential of producing biofuels and biogas.

Referring to the import of energetic resources, we can say that, at the moment, Romania is placed third in the European Union, with the lowest level of primary energy imported. If in 2015 the net import was 16% out of the primary energy, it is estimated that before 2030, if the hydrocarbon resources will end, the import is not going to overcome 25% out of the internal usage. [4]

Electricity Production

Regarding the production of electricity, it can be said that Romania's primary energetic resources are the indigenous ones. The energetic mix is a diverse one with an increase of the renewable energy component being desired.

If we analyze the period of time between the years 2015 and 2016, we can observe how the energy mix suffered certain changes regarding the coal, hydro, natural gas and aeolian components. This way, an increase by 2% is noticed for the hydro and natural gas components, a decrease by 3% for coal and by 1% for the aeolian one. As it can be seen in Table 1, the rest of the components remain at a ratio value.

The biggest problem that Romania is facing is still the old age of the electricity generating capacities, oldness that is close to 30 years, which means that their technical functioning length is close to an end, parts of them being closed often for reparations. [7]

Table 1. The electricity production- the energetic mix
(data provided by the Romania Energetic Strategy)

Electricity Mix	**2015 (%)**	**2016 (%)**
Coal	28	25
Hydro	27	29
Nuclear	18	18
Natural Gas	13	15
Aeolian	11	10
Photovoltaic	2	2
Biomass	1	1

In the year 2015, 40% of the annual electricity production is done by the thermoelectric capacities, which are based on coal and natural gas.

Also shown in the table above is the fact that Romania continues to use nuclear energy, our country being one of the 14 states members of the European Union that can produce a part of their electricity this way. This type of electricity production could be increased by 10% if two other reactors would be put in use in the future at Cernavoda. This action will also determine an increase of the pressure upon the competitiveness of the natural gases and coal producers.

Looking over the projects that needs to be implemented by the year 2020, we could mention that the natural gases station with combined cycle from Iernut, project made by the Romgaz company and also the investments done by the Hydroelectrical company, investments that aim at the finalization of 200MW new capacities and the upgrading of the existing ones. Also, for the past 5 years, more aeolian and photovoltaic (4500MW) capacities came to life, leading to a downgrade of the electricity price and import, as well as an upgrade of the targets for the reduction of the natural gases with greenhouse effect for the year 2020. Nevertheless, the aeolian stations produce more energy during the evening and winter, while the photovoltaic ones produce more energy during the day and in the summer.

According to the data provided live by the Transelectrica [8], on 02/03/2017, the biggest component of the electricity production was the usage of coal 30.55%, followed by hydrocarbons 21.74%, the hydro component 17.18%, the nuclear component 16.55%, aeolian 9.6%, photovoltaic 3.74% and only 0.63% for the biomass.

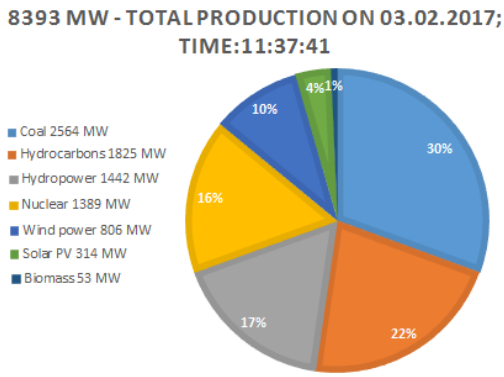

Figure 4. The components of the electricity production mix, february 2017

Looking at the data provided by Transelectrica on their official website [9], we determined the consumption, production and its components for the year 2016. In order to do this analysis, we selected the last day of each month of the year, comparing the data that was registered between 1 p.m. and 2 p.m. The data is presented in Table 2 and Figure 5.

From the data that was presented, it can be observed that the biggest consumption was registered in October 2016 (7554MW), closely followed by February (7504MW) and June (7443MW). The biggest electricity productions in 2016 were registered in October (8835MW), June (8800MW), August (8491MW) and November (8328MW), the differences between consumption and production being shown as the negative balance represents the energy export.

The only months in which the consumption was bigger than the internal production were September with a - 314MW difference, March with - 259MW and May with - 9MW.

Analyzing the energetic mix in 2016, we can observe the fact that a big part of the internal production was represented by the following components: water, coal, nuclear and hydrocarbons. The smallest ratio belongs to biomass, followed by the photovoltaic and aeolian components, the last two depending a lot on the season and weather conditions.

At a first glance over the Table 2, the values in May appear as „intruders" in the regular mix ratio, with a consumption that exceeds only with 9MW the internal electricity production, whose componence is dominated by the usage of water and coal. The values for the hydrocarbons, nuclear, aeolian, photovoltaic and biomass components remain among the lowest throughout the year, with a production average of 366MW.

Table 2. The electricity consumption, production and its composition, 2016

Date	Consumption [MW]	Average Consumption [MW]	Production [MW]	Coal [MW]	Hydrocarbons [MW]	Water [MW]	Nuclear [MW]	Aeolian [MW]	Photo[MW]	Biomass [MW]	Sold [MW]
January	6542	6553	7894	1809	1149	1248	1325	2159	155	48	-1352
February	7504	7501	8012	1726	959	2167	1339	1443	328	51	-508
March	6797	6837	6538	1439	824	1879	1361	295	697	42	259
April	5721	5727	6295	1023	609	2553	1404	56	601	48	-574
May	6941	6923	6932	2087	362	3068	704	77	640	45	9
June	7443	7437	8800	1849	868	2841	1328	1169	707	38	-1357
July	6071	6110	6832	1746	804	2051	1381	84	718	48	-762
August	6954	6995	8491	1614	1326	2160	1325	1393	633	41	-1537
September	6541	6624	6226	1718	619	1693	1377	32	720	67	314
October	7554	7610	8835	2217	1218	2423	1382	1183	357	55	-1281
November	7283	7279	8328	1864	1707	2861	1326	152	355	61	-1045
December	6908	6927	7762	1829	1657	1741	1407	677	435	43	-854

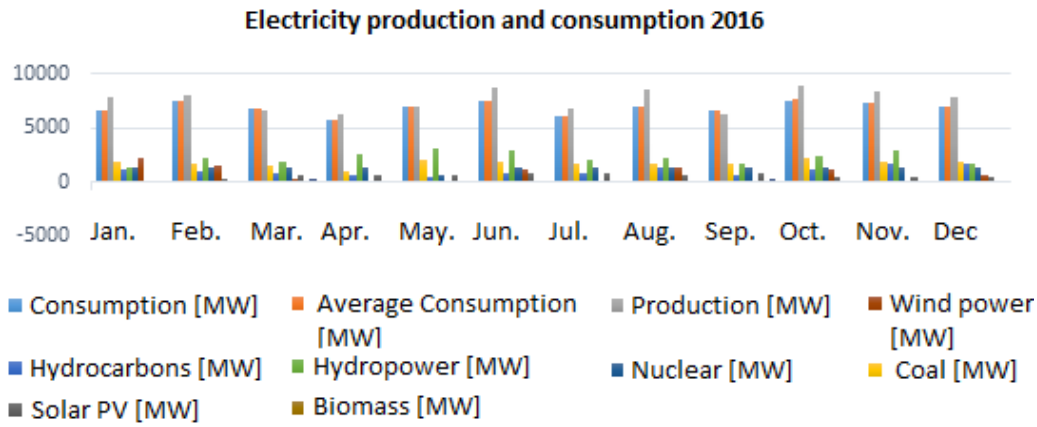

Figure 5. Electricity production and consumption, 2016

If we are referring to the primary energy production evolution in Romania, looking at the source of energy, we can say that in 2015, the biggest ratio for primary energy production

was registered for natural gas, with 34%. After the modelling of the Optimum Script, it is expected for this value to drop with 3% until 2030 and with 12% until 2050.

A big decrease of the ratio is also foreseen for the energy coming from petroleum, which will get from 15% in 2015 to 7% in 2030 and only to 5% in 2050. Coal is also registering a decrease, getting from 18% in 2015 to only 4% in 2050.

On the other side of the evolution of the primary energy production is the geothermal energy [5], which although in 2015 had an insignificant ratio, until 2050 it is expected to reach 1%. Another significant increase is given by the solar energy, which from 1% in 2015 will get to 2% in 2030 and even 5% in 2050.

Aeolian energy will be even more exploited, doubling its ratio until 2030, registering 9% out of the total energy produced until 2050. Biomass and dump goods are also registering an increase for the next years, from 14% in 2015 to 16% in 2030 and 24% in 2050. Nuclear energy is also registering a spectacular increase, doubling its ratio until 2030 (from 11% to 22%) and reaching 24% in 2050. Hydro energy remains with almost the same ratio in the energy production mix, with values of almost 18% in 2030 and 2050.

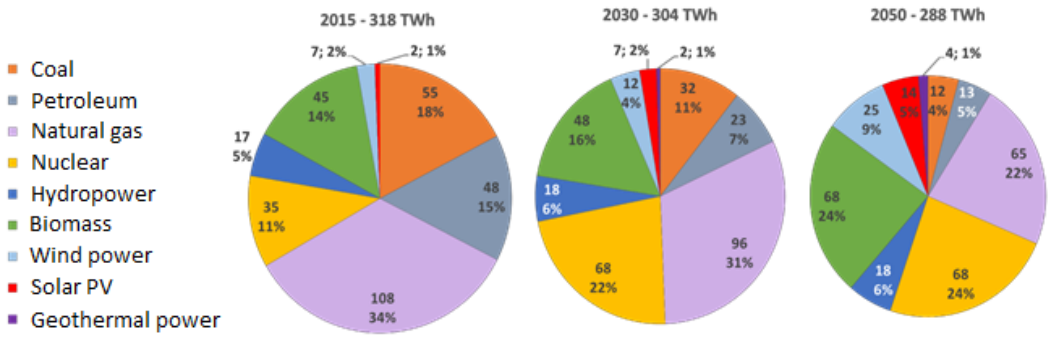

Figure 6. The primary energy production evolution in Romania, by token of the energy source (Source: PRIMES)

The role of the investments done in this energetic sector remains a very important factor for everything that means the study and the insurance of the energetic efficiency. This way, for the time between the years 2030 and 2050, the level of expenses from the investments in energy rises up to 5.7% in 2030, 5% in 2035, 5.3% in 2044 and 4.9% in 2050. On average, between 2030 and 2050, investments in the energetic sector will be around 665 mils. Euro (exchange rate from 2013).

Following the PRIMES modelling results, The Ministry of Energy foresees the following decarbonating target values for the next years:

Table 3. Indicative decarbonating targets for the years 2020, 2030 and 2050

Indicator	U.M.	2015	2020	2030	2050
Reduction of greenhouse effect gas emsions	% compared to 1990	54	55	62	75
Ratio of energy from renewable sources	%	26,3	24	27	47
The intensity of energy in economy	tep/mil €2013	218	190	155	105

Although the decrease of the greenhouse effect gas emissions should be around 80% compared to year 1990, after the modelling of the Optimum Script, this value is only 75% in 2050 for Romania. This target could be reached by 2050, but with huge investments effort. In any case, these models took into consideration the fact that an energetic streamlining of homes is desired and an acceleration of transport and support for the Romania Energetic Strategy through the offering of subsidies. This fact would make the rest of the necessary investments for covering the other 5% for the reduction of GES unjustifiable from a financial point of view, their value being way too high.

Until 2020, the ratio of renewable energy sources will reach 24%, for 2030 a value of 27% being desired while for 2050 the value will be of 47%.

As it can be seen in Table 3, the energetic intensity in economy has a tendency of decreasing for the years 2030 through 2050.

CONCLUSIONS

This paper offers a general image over the status of Romania's energy sector compared to the registered average in the European Union and the targets that are desired to be registered in the future.

One of the most important aspects addressed in this paper refers to the study of the structure of the primary energy mix, the paper including an analysis of the registered data in 2015 and the targets that needs to be reached until the year 2030.

Thereby, the biggest difference registered shows the increase of nuclear energy as a percentage in the structure of the energy mix (8%), and also the decrease of the coal consumption (7%).

Another analysis presented in this paper refers to the demand of final energy on the activity sectors, analyzing the data from 2015, targets from 2030 and from 2050. The highest ratios were registered in the household sector (34%), on the opposite side being the agriculture and services, with a percentage of only 11% in 2015. The order of the ratios from the targeted sectors is being kept the same until 2050, the ratios increase or decrease in the energy demand evolution being of only a few percentages throughout the 35 years that are being analyzed.

Referring to the production of electricity, a case study presented with the help of the data taken from the Transelectrica website triggers a warning signal regarding the components of the energy production mix at the beginning of 2017. The highest ratio in the mix belongs, unfortunately, to coal (30.55%), on the opposite side being the renewable sources -aeolian, photovoltaic and biomass.

Going back to the study comparing the situation in the year 2015 and the targets that are desired to be reached until 2030, 2050 respectively, the primary energy production in Romania states, first of all, the massive decrease of energy produced from the usage of coal (from 55% in 2015 to 12% in 2050) and the increase of energy coming from alternative sources. Also, another interesting target refers to the usage of nuclear energy, which is not used at maximum capacity in our country.

In the future, the authors are aiming to go even further with this study, to see which is the current status of the liberalization of the energy market in the member states of the European Union, emphasizing the existing situation in Romania and the way in which the liberalization affects the country economically.

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