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Infrastructure Report Romania

Activity A.T2.2: Infrastructure analysis

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The potential for exploitable organic residue for each participating country listing key aspects such as location, amount, transport options and costs.

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CONTENT

1. METHODOLOGY

Several types of data were collected in the infrastructure database. The sources were diverse. The infrastructure database contains both qualitative and quantitative data. Some of them were more accessible. Furthermore, regarding the energy infrastructure in Romania, it exists, but the data on its existence as well as other more precise data (technical data, data on capacities) are difficult to identify, being often unavailable.

Regarding the Renewable Energy Plant, the data were collected from the ANRE website - which stands for the National Energy Regulatory Authority. This institution has a list of authorized renewable energy plants and producers, where the installed power and source are specified. From that list, the highest values were selected. The connection points were identified using the map provided by Transelectrica on its website, which shows the National Transport Network. (Figure 1)

The industrial plants were identified by an internet search. Only the largest nationwide data were entered into the database

Also from the Map of the National Energy Network were extracted both the transnational connections and other location elements. Transport hubs, coordinates were identified using online mapping services, where coordinates were taken into account.

*Note. Transport hubs were often chosen that were more accessible in terms of infrastructure than those that were closer. That is, in some cases the so-called "air" distance was not taken into account.

Qualitative elements regarding the installed power, type of voltage, pressure or water flow were identified via online search. Some of these could not be identified at the time of this study.

After collecting data on energy infrastructure, it can be concluded that it is quite dense and largely meets the energy needs of the country. Import-export flows vary depending on the production of energy at a time when it is not required to be delivered to the grid and is exported. Subsequently, there are cases in which consumption is higher than production and energy is imported.

As for renewable energy plants, they have become quite popular, not only them but also the means of renewable energy production that are applied by the owners to their

own businesses, households or real estate of any kind. The most popular sources of renewable energy in Romania at the moment are wind energy and that which is obtained with the help of folovoltaic panels. Capacities are growing steadily in recent years and the results are beginning to show. In the first months of 2022, there were cases in which the wind turbines on the Black Sea coast due to the wind that blew at high speed, provided up to 30% of energy production for certain time intervals of the day in question.

For a better perspective of the energy situation in Romania, values have been offered in several units of measurement expressed in kilowatts per hour and megawatts per hour, compartmentalized price lists will be put in several time intervals and from several acors of the energy market and will go through the energy history of the country in recent years.

The graphs in this study were made using Microsoft Excel.

The price lists presented are public. As stated above, comparatively more prices will be presented from different periods and from different institutions. The values were presented by the operators / energy suppliers in Romanian lei. These have been converted into Euros. The conversion was made on March 16 at the BNR (National Bank of Romania) exchange rate on the same day.

At the time of elaboration of this study, certain measures to be applied in the field of energy are also considered (from price capping measures, reduction of certain taxes or planning of future investments that will be mentioned punctually and contextually in this document).

This study presents the energy situation, interpreted, detailed and analyzed as it is in March 2022. Currently there are several elements that are variable in the energy market, from actors, suppliers, prices, the legislative framework and which in the near future they can be changed.

In some cases, due to several price values, the average value was used, and due to the lack of annual data, monthly, daily or quarterly data were used.

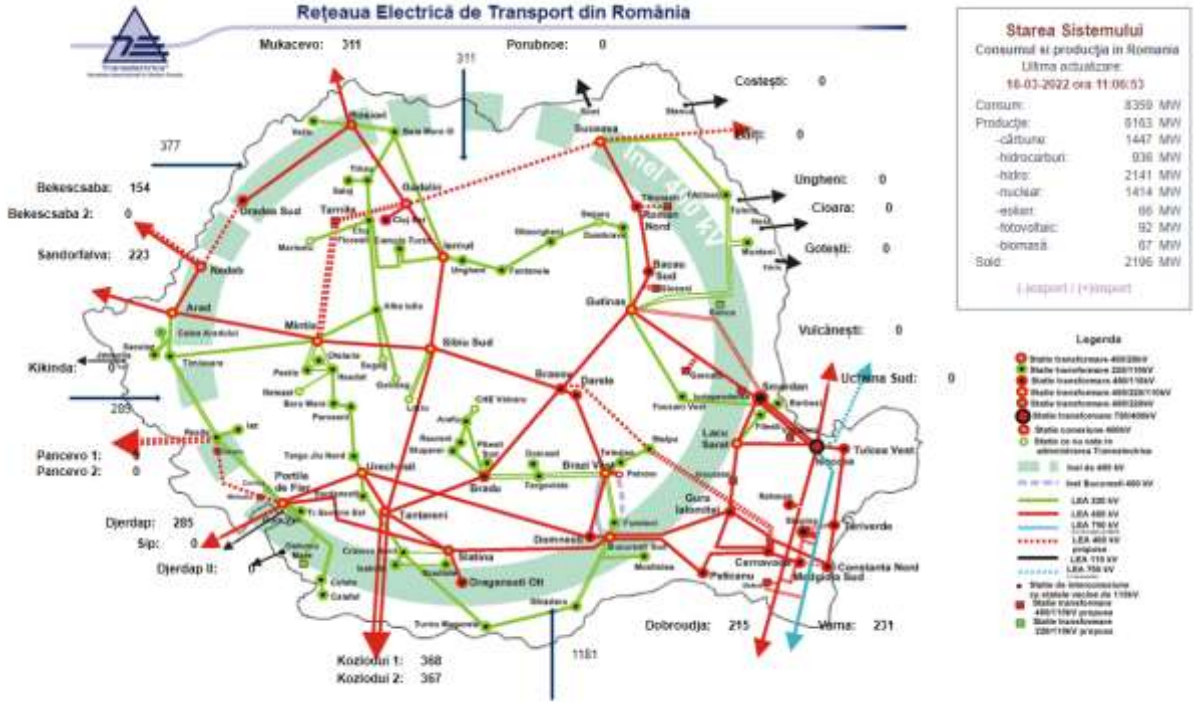

Figure 1. The Romanian electric transmission network with the production and import / export values on March 16, 2022, at 11 AM.

2. BRIEF DESCRIPTION OF ROMANIA INFRASTRUCTURE LANDSCAPE

As mentioned above, the energy situation in Romania is stable, in terms of energy production, import and export. Comparing the values of the last years does not identify any anomalies, increases or sudden decreases of the values.

Renewable energy occupies on average about 20% of the total energy production and in terms of daily values in some cases this value rises to over 30 percent. It is mentioned above, the case of some days in 2022 where the wind speed caused the wind turbines alone to produce 30% of the total energy without taking into account other renewable energy production sources. However, the average annual rate is just over 20%.

Renewable energy sources are becoming more and more popular in Romania, which must take full advantage of them in order to increase its degree of energy independence but also to become more energy efficient.

The production of hydroelectric energy is dominated nationally by the Romanian state through the company Hidroelectrica, which is the largest with a value of 3.5 billion Euros.

The largest hydropower plant in Romania is Portile de Fier I. The Porțile de Fier I hydropower plant is the largest hydropower plant on the Danube River and has an installed capacity of 1,166.4 MW. Downstream there is also the Iron Gates II hydropower plant, with an installed capacity of 251.2 MW. Both hydropower plants are operated in partnership with Serbia, totaling 2160 MW, and those at Iron Gates II totaling 500 MW; the maximum installed flow of the power plants is 8,700 m^3 / s. The Iron Gates I power plant is located 15 km upstream from the town of Drobeta Turnu-Severin, and the Iron Gates II power plant is 60 km downstream. Other important hydropower plants are Lotru Hydroenergetic Power Plant, Vidraru Hydroelectric Power Plant, Dimitrie Leonida Hydroelectric Power Plant (Stejaru), Mariselu and Remeti Hydroelectric Power Plants, Raul-Mare Retezat Hydroenergic Power Plant and Ruieni Hydroelectric Power Plant and Gilcea Hydroelectric and Sug Power Plants.

Regarding the production of nuclear energy, the production of nuclear energy is owned by the Romanian State through the company Nuclearelectrica. It owns the Cernavoda Nuclear Power Plant, which has a capacity of 4 reactors of which only two are installed, the first in December 1996 and the second in September 2007. The Romanian state intends to build two more nuclear reactors, with an estimated investment of about 4

billion euros. The capacity of the plant is 5 reactors, but only a maximum of 4 can be installed due to technical conditions.

Thermoelectric energy is provided by thermoelectric power plants (CET, as they are called in Romanian), most of them belonging to Termoelectrica, the largest player in this field of energy production.

In 2006, the electricity produced from fossil fuels was 38.4 TWh at an installed capacity of 10,598 MW (based on coal: 26.9 TWh and 6,189 MW, and based on hydrocarbons: 11.5 TWh and 4,409 MW).

Following the successive restructurings, a significant part of the thermal power plants were transferred to the Romanian state and implicitly to the company Termoelectrica. Among them are CET Deva and Elcen Bucharest, which have an installed capacity of 5,520 MW. The rest of the power plants, namely CET Turceni, CET Rovinari, CET Craiova operate as separate companies, or under the tutelage of local councils

The three energy complexes in Oltenia (Turceni, Rovinari and Craiova) cover about 1/3 of Romania's electricity production, and are on the 3rd place nationally after Hidroelectrica and Nuclearelectrica, the producers of the cheapest energy in the country.

The hydropower potential of the country is 36 TWh / year, of which about 30 TWh / year can be capitalized in conditions of economic efficiency.

Regarding the electricity market

- Thermoelectrica, Hidroelectrica, Nuclearelectrica and the independent CHPs (Electro Thermal Power Plants) produce electricity. All these companies are owned by the Romanian State.

- Transelectrica, majority owned by the state (90%), provides the national transport of electricity

- Electrica deals with the distribution and supply of electricity.

- OPCOM, a company in Transelectrica's portfolio, oversees the electricity exchange.

Following the liberalization of the market, there are now other players on the electricity market, some of them being private companies that have purchased production capacities (micro-hydropower). There are also private companies on the market dealing with electricity trading.

2.1ELECTRICAL ENERGY SECTION

The energy market liberalization measure entered into force in January 2021 through Ordinance 20/2021, which is a modified and final version of the previous orders. The most important thing is to amend Article 4 of the previous order. Thus: "(1) From 1 January 2021, following the elimination of regulated tariffs, household customers who have not chosen a competitive offer and have not concluded a contract on the competitive market have the right to be provided by the suppliers of last resort In the case of these customers, the supplier of last resort shall apply the offer price for the universal service, established in accordance with the provisions of the Annex to this Order.

As stated in the methodology section, some electricity providers offer prices in kilowatts per hour and others in megawatts per hour. For a better understanding of the prices, values were offered in both units of measurement. The price lists in this study were taken from several electricity suppliers.

Regarding Figure 2, it is very important to read the note. Prices differ depending on the region, but in the case of amounts with 2 or 3 decimals in lei, their conversion into euros would have led to values that are difficult to analyze. Thus, the average between the region with the highest price and the region with the lowest price was take.

In other words from 2021, the complete liberalization of the electricity market was regulated. Households will no longer have to pay prices that are set by the National Energy Regulatory Authority. The same thing happens with non-household consumers. The clients are now able to compare supply offers and choose accordingly.

The price on the balancing market is now freely determined by the supply-demand mechanism. Also, a very important mention is that this mechanism can reach negative values. The participation of the balancing market is now a matter of free choice.

Electricity price - January 2022 EURO kWh	0.65	High voltage distribution tariff - EURO kWh	0.0042	High voltage final price - EURO kWh	0.68
Supply component ppff EURO kWh	0.081	Medium voltage distribution tariff - EURO kWh	0.0088	Medium voltage final price - EURO kWh	0.75
Electricity extraction component from the network - TL	0.0044	Low voltage distribution tariff - EURO kWh	0.029	Low voltage final price - EURO kWh	0.78
System services tariff - EURO kWh	0.0019	Note : Note. The prices shown above are average between the regions of Romania. Although the prices displayed above differ depending on the region, the values in lei (differences are in the order of decimals) so that the conversion from Romanian leu to Euro would make the values displayed in European currency not change to two decimal places.			

Figure 2. Price for electricity (Euro/kWh)

Regarding the prices in MWh, they offer a possibility to better analyze the situation of price differences depending on the region of Romania. There is no region with higher prices for all categories but there are differences.

By analyzing Figure 3 and Figure 4 the following results :

- the highest price for high voltage in Oltenia, while the lowest is in the South Muntenia Region

- the highest price for low voltage is also in Oltenia and the lowest is also in South Muntenia

- in terms of low voltage, the highest price is in Dobrogea and the lowest is in the northern part of Transylvania

It can be observed that in terms of other taxes, the highest value is the transport and transmission fees, both over 4.5 Euro, while the network introduction fee is significant and the system fee is below 2 Euro.

Region	High voltage distribution tariff - EURO MWh	Medium voltage distribution tariff - EURO MWh	Low voltage distribution tariff - EURO MWh
Banat	3.23	8.7	23.8
Dobrogea	4.08	8.65	27.32
Muntenia South	2.1	6.98	22.69
Moldova	4.02	8.59	26.21
Oltenia	5.51	10.39	25.81
Muntenia North	3.78	7.71	25.85
Transylvania North	3.89	9.53	21.75
Transylvania South	4.49	9.15	22.5

Average tariff for electricity transmission service EURO MWh	Transport tariff - the component for introducing electricity into the network - EURO MWh	Transport tariff - the component for extracting electricity in the network - EURO MWh	System services tariff - EURO kWh
4.84	0.3	4.54	1.88

Figure 3. Price for electricity (Euro/MWh)

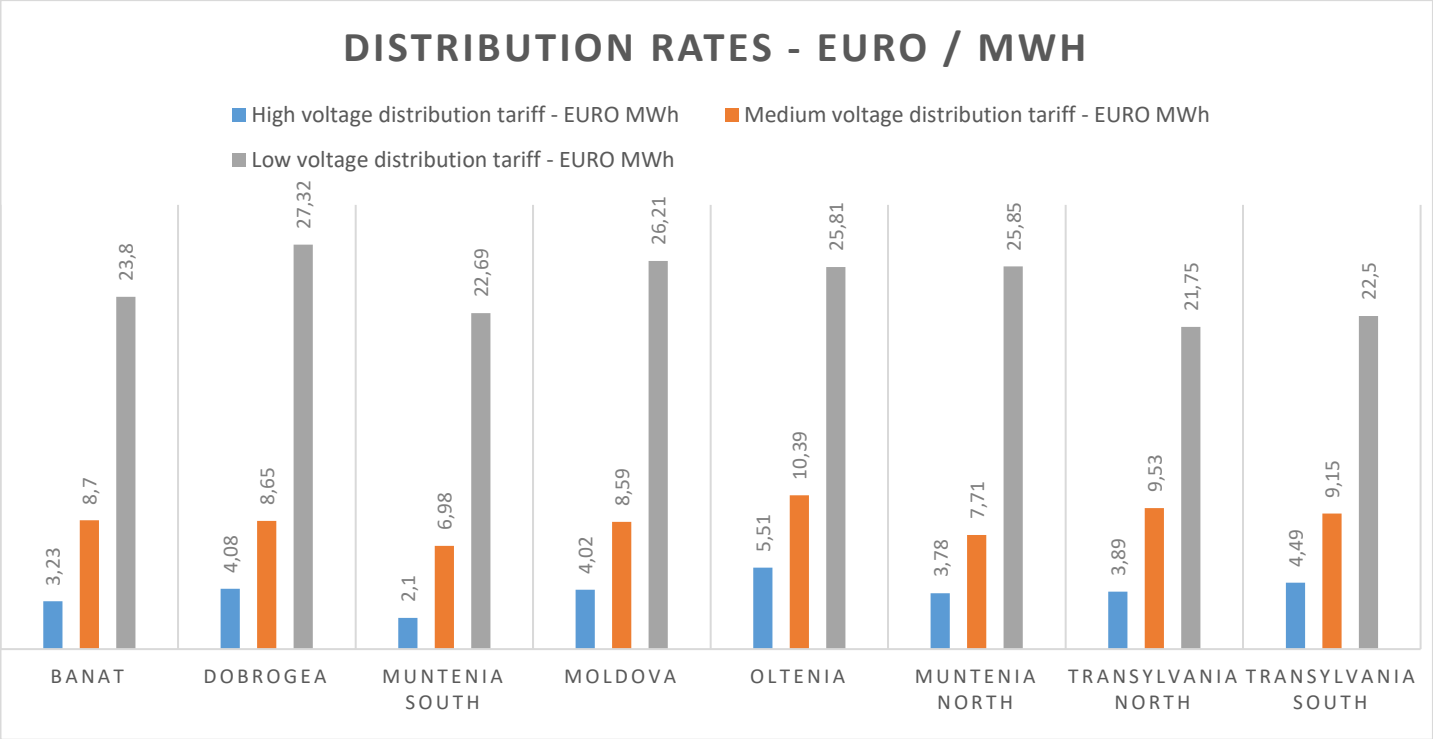

Figure 4. Electricity distribution tariff (Euro / MWh)

Regarding the secondary and tertiary operators, the Romanian state does not differentiate between them. The only distinction that the Romanian state makes is between domestic and non-domestic operators.

Figure 5 shows the price offer of a supplier expressed in Euro per kWh.

*** Note: The situation with the prices in the table in figure 5 is similar to the one in the table that belongs to figure 2. The prices in kWh have low values in Euro, values for which

"Energy price (includes power input component in the grid -TG) "	0.089	Distribution tariff - High voltage	0.0058	Price of supply of active electricity without VAT - High Voltage	0.099	Green certified counterparts	0.015	Final price for Universal Service with VAT - High Voltage	0.14
The transport tariff for the electricity extraction component from network - TL	0.0039	Distribution tariff - Medium voltage	0.011	Price of supply of active electricity without VAT - Medium Voltage	0.11	High efficiency cogeneration contribution	0.0052	Final price for Universal Service with VAT - Medium Voltage	0.14
System service fee	0.0022	Distribution tariff - Low voltage	0.007	Price of supply of active electricity without VAT - Low Voltage	0.13	Excise	0.00658	Final price for Universal Service with VAT - Low Voltage	0.18

the differentiation would have been seen in the case of 5 decimal places. Thus, the average between the most expensive region and the cheapest was made.

Figure 5. Electicity price for non-household consumers (Euro/kWh)

Time frame		Medium voltage price (Euro / MWh)	Low voltage price (Euro MWh)
Package no.1 - 2 time frames	Day 1	73.92	101.68
	Night 1 & Weekend	53.01	80.77
Package no2. - 2 time frames	Day 2	69.25	97
	Night 2	51.8	79.55
3 time frame	Time zone with the highest consumption	74.51	102.27
	Time zone with the lowest consumption	51.8	79.55
	Time zone with normal consumption	71.23	98.99
*** Where the weekend is FRIDAY 22.00 to MONDAY 07.00			

Figure 6. The offer of a supplier with differentiated rates depending on various time intervals

Unfortunately, at the time of writing, no data were found on suppliers' offers for non-household consumers regarding the price of energy depending on the different times of the day, week or month.

The only such offer that has been identified dates back to before the energy market was released and can be seen in Figure 6. It offers 3 different offers (two of them for two time slots, and another 3 different prices depending on consumption). The bids were for medium power supply and low voltage.

However, the tariffs presented above will wait until they enter into force. In March 2022, the Prime Minister of Romania announced measures to cap the price of electricity. This will result in a new set of prices that will enter into force in April 2022 and will remain in force for 12 months.

- consumption of up to 100 kw per month will be paid 0.14 Euro kWh

- for a monthly consumption between 100 and 300 kw, 0.16 Euro kWh will be paid

For gas, the price charged for households will be 0.063 Euro kWh

All Romanian companies will benefit from a fixed price, for electricity, of 0.20 per kw, VAT included, and 0.075 Euro / kw for gas, VAT included

Regarding VAT: in terms of energy, the standard VAT is 19%, but as in the case of prices, from April 1, 2022 for a year, household consumers who fall below a monthly consumption below 300 kWh will benefit by reducing VAT.

*** Important note: These things are for information only. Recommendation in the elaboration of other studies is to take into account the VAT at its value of 19% and the prices as they are stipulated in the tables in this document.

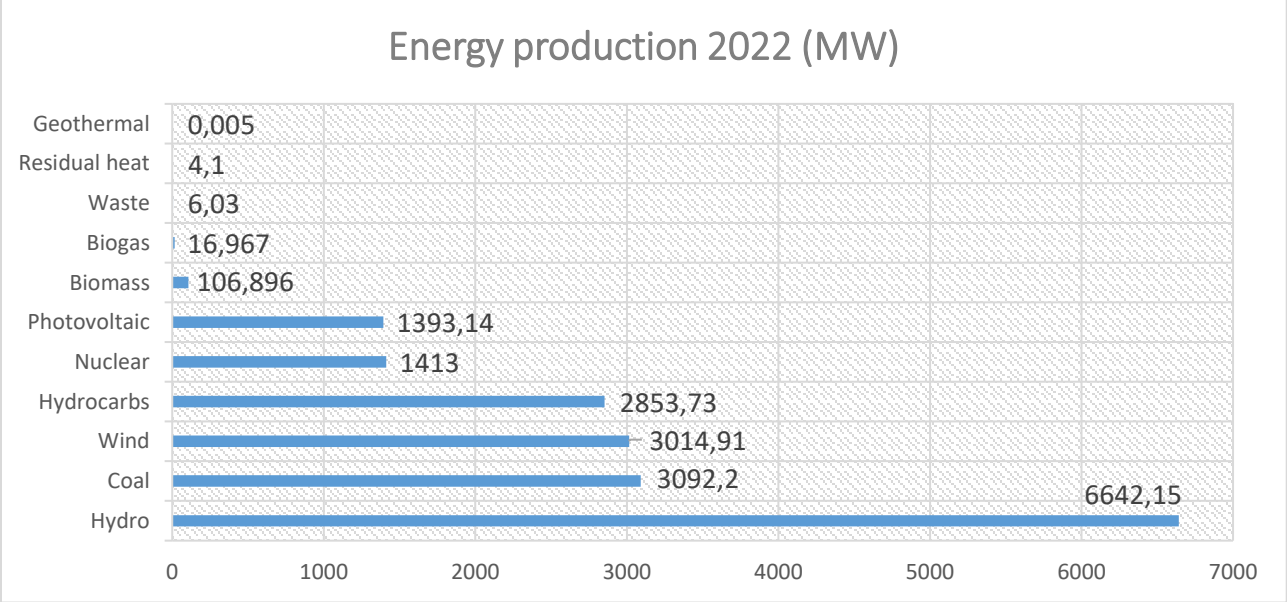

Figure 7. Energy production

It can be seen that the trends of the 2000s still apply today, as energy production for the year 2022 to the present is dominated by electricity produced by hydropower plants with

a double value compared to the energy produced by coal-fired power plants which is declining. . This is also due to the national desire to reduce coal mining, although it is estimated that in the Jiu Valley and Motru Rovinari area (the main coal regions of the country are still resources for decades to come). The mines were gradually closed, but in the context of 2022, when we talk about the "energy crisis" at European level, we consider that they should be reopened as a solution to the damage. This would require investment because coal mining and power plant infrastructure would have to undergo maintenance processes to be ready for use in case of need.

Two of the interesting values in the graph in Figure 7 are the large share of energy in the total energy that was produced by wind turbines. In fact, it is noted that solar energy has an almost equal value of energy produced from nuclear sources. These things are due to the investments, promotion strategies and subsidies and interest granted by the Romanian state not necessarily for renewable energy in general but for these two forms of production in particular.

This is encouraging because in the context of the DanuP-2-Gas project, if this can be done in the field of energy produced by solar panels and wind turbines, it means that in the future the use of biomass (which is also an increase) can be encouraged. , but not such a big increase) but also in the field of Power to gas, and steps and strategies can be taken in these directions.

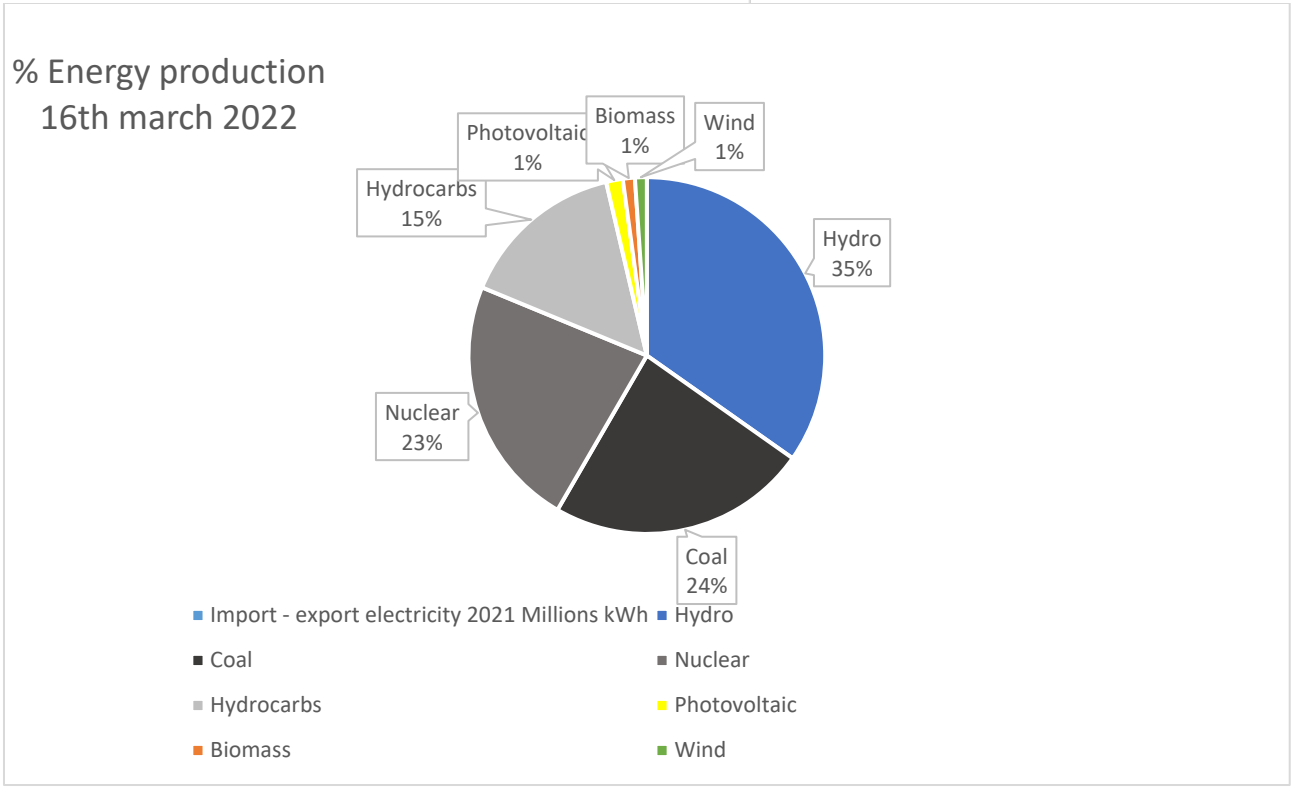

Figure 8. Energy production 16th march 2022

A particular case that can be analyzed is that of March 16, 2022. It can be seen that here the values of electricity production from renewable sources (wind, solar, biomass) are quite low, while the methods already established nationally thermal power plants , hydropower plants and nuclear power plants have stable values.

In fact, this is the main problem. The Romanian state produces energy from renewable sources but at a fluctuating variable level. Thus, independence and energy efficiency cannot yet be attributed to renewable sources of electricity production, but rather renewable energy can support this approach, but only at certain times.

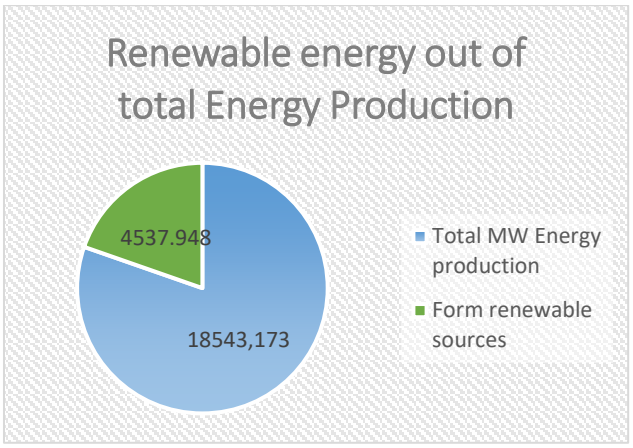

Figure 9. Renewable energy percentage out of total energy production (2022)

Energy production 2022	
Source of production	MW
Hydro	6642.15
Coal	3092.2
Wind	3014.91
Hydrocarbs	2853.73
Nuclear	1413
Photovoltaic	1393.14
Biomass	106.896
Biogas	16.967
Waste	6.03
Residual heat	4.1
Geothermal	0.005
Total	18543.173

Figure 10. Energy production 202

Regarding the export, the situation is good at national level, given the fact that Romania exports more than it imports, so it cannot be about an energy inflation. There are also some worrying signs that imports have increased by 23% in 2021 compared to 2020 and exports, although they have increased, have also increased by only 6.7%. This can also be attributed to the Lockdown caused by the Covid 19 pandemic in 2020. Perhaps without this episode the values would have been more amortized. The problem may also be that Romania does not have enough capacity for the network and thus energy in the form of alternating current (which cannot be stored) must be exported from the national system. Below in figure 11, the graph for energy import-export in 2021.

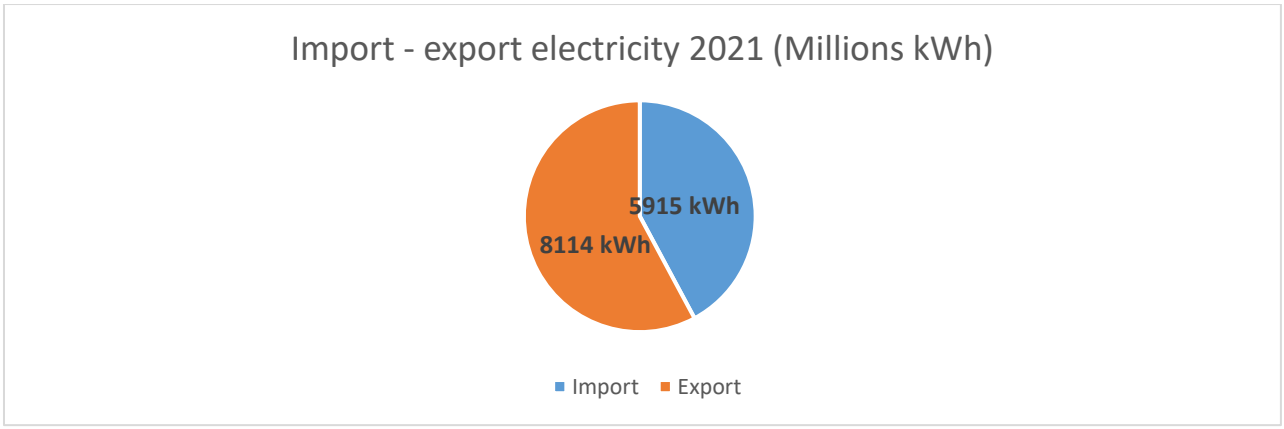

Figure 11. Import and export of electricity for 2021

2.2 NATURAL GAS ENERGY SECTION

Romania has proven natural gas reserves of over 100 billion cubic meters and in terms of estimated reserves the value stipulates exceeds 600 billion cubic meters. Most of Romania's natural gas resources are located in the Transylvanian Hilly Depression, outside the Carpathian arc in Muntenia, Moldova and the Black Sea, with approximately. More than half of them are in Transylvania, especially in the counties of Sibiu and Mureș.

Romania's total natural gas consumption in 2006 was 17 billion cubic meters, of which 70% was domestic and 30% (5.1 billion m³) was imported.

Natural gas provides about 40% of Romania's energy consumption.

In 2014, however, gas imports fell to just 1 billion m³, or 7.5% of Romania's total consumption. There was also a decrease in consumption to 12 billion. m. The main reason for the decrease in consumption and imports was the adjustment of the industrial sector, especially chemistry and petrochemistry. And the structure of domestic gas entered into consumption in September 2014 was led by OMV Petrom with more than 54%, followed by Romgaz with 41 percent and other actors but smaller.

Natural gas price - Euro / MWh	112.19
Transport cost - Euro / MWh	2.43
Distribution rate - Euro / MWh	6.09
Supply price - Euro / MWh	76.82
Supply price - Euro / kWh	0.14
*** Note. The offers of the natural gas suppliers are placed on the ANRE website following the liberalization of the energy market. Every citizen can choose. At the time of drawing up this table, the average natural gas price, the average supply price per kWh and MWh were calculated. The same procedure was performed regarding the transport	

Figure 12. Gas price and other taxes

The natural gas market has been subject to the same regulations as the electricity market. Thus, many of the regulations that apply to electricity also apply to the natural gas market. The natural gas market has also been liberalized. One difference is that here the prices are not different depending on the region.

Therefore, the price of gas will also be capped, as will the price of electricity.

The price charged for households will be 0.063 Euro kWh.

Packages with capped prices will be made available to non-household consumers.

VAT in the case of natural gas is also standard at a value of 19% but will also be reduced as in the case of electricity to 5%. The measures will take effect on April 1 and will last one year.

Regarding the price, with the liberalization of the natural gas market, various suppliers offer several price offers. The prices in the table in figure 12 represent the average between the highest and the lowest price that were offered in lei and then converted into euros at the exchange rate specified in the methodology.

* Note: In March of this year, 2022 (the moment that overlaps with the elaboration of this document) the parliamentarians discuss the final version of the so-called offshore law, a law that regulates the conditions for the exploitation of natural gas reserves in the Black Sea.

2.3 BIOCHAR SUPPLY SECTION

At the time of this study there is no economic, legislative information about biochar. There is no clear difference in Romania between biomass and biochar. Therefore there are no shipping prices.

2.4 WATER SUPPLY SECTION

Price of drinking water produced, transported and distributed Euro / m3, T.V.A. Inclusive	Sewerage / sewerage tariff - treatment, Euro / m3, T.V.A. Included	Total price (Euro) VAT included
1.06	0.83	1.89

Figure 13. Water supply cost in Euro/m3

Depending on the county, the costs change depending on the distance to the water source and many other variable elements. The prices for all the counties were taken into account and an average was made in lei which was then converted into Euro at the rate specified in the methodology.

Name of the service	Unit of measure	Price Euro without VAT	VAT 19%	Price EUR with VAT
Execution of new connection from 20-100 mm	Euro / ml	131.39	24.96	156.35
Execution of new connection dn 160-300 mm, h <2,5m	Euro / ml	242.56	46.09	288.64
Execution of new connection dn 160-300 mm, 2,5 <h <4,5m	Euro / ml	323.41	61.45	384.86

Figure 14. New water connection prices

To these costs are added other costs such as

- issuing the permit - 36.08 Euro smaller location 500 m2 / 0.087 Euro larger locations 500m2 / 505.33 Euro larger locations c 5,835.67 m2 / 909.60 Euro larger locations 10,000 sqm
- technical consulting - 60.13 Euro
- the cost of designing the connection - 384.86 Euro
- the cost of the meter - 174.15 Euro Dn (mm) 15 / 1520.20 Euro Dn (mm) 100 / 3308.83 Euro Dn (mm) 200

In terms of well drilling, the prices differ depending on the depth and diameter and the pedological / geological conditions. Below a list of average prices.

- 30-40 eur / m - drilling in soft soils (sands and algae) that do not require consumption of bentonite, polymers, with the current 380 v of the beneficiary, accommodation table equipment also in areas where aquifers are found in sands / gravel with granulation which does not require the use of special quartz filter pebbles, in areas with high flows that ensure a rapid clarification of water, etc. - in Romania only a few cases of such drilling
- 40-60 eur / m - are the most common, in soils where there are small problems (boulders, limestone, sandstone, marl, etc.), where aquifers are located in fine sands and require special granular quartz for filtration, in areas with low debits where clarification can take up to 3 ..4, in the case of beneficiaries who want execution in the field without providing any utility for days.
- 60-80 eur / m - for soils with major difficulties, with diameters> 140 mm,
- 80 eur / m special projects, with special operations / materials