CONVENTIONAL AND UNCONVENTIONAL ENERGY RESOURCES

Raluca Ana-Maria DUMITRU[110]

Abstract

Economic development, economic structure and energy efficiency measures are the main factors influencing domestic consumption of primary energy. The main restriction is the limited nature of internal fossil fuel resources and declining domestic production trends, which leads to increased dependence of the country on primary energy imports.

An accurate assessment of the possibilities to meet the need for primary energy resources in perspective must start from the current situation of certain reserves, correlated with the realistic estimation of potential resources and closely related to the projected consumption of resources determined by final energy demand.

Key words: energy infrastructure, renewable energy, conventional and unconventional energies, energy potential, energy resources.

JEL Classification: K32, O1, P28, P48, Q01, Q4, Q5.

Regarding exhaustible energy resources, a fair assessment of the possibilities to meet the needs of primary energy resources in perspective should start from the current situation of safe reserves, correlated with a realistic estimation of potential resources and in close interdependence with the projected consumption of resources by the demand for final energy.

Thus, it is estimated that lignite reserves can ensure their efficient exploitation for about 40 years at a production level of about 30 million tons/year[111]. In the lignite extraction sector, the level of state intervention is diminished, being restricted to subsidies only for underground exploitation, a subsidy that will be eliminated over time.

As regards the huila[112], the restriction of the perimeters and the closure of the non-performing mines led to the situation in which only about 30% of the total geological reserves of coal are still found in the CNH-SA concession perimeters. According to the recently adopted EU Directive, the European Union allows the continuation of the subsidy for the exploitation of the coal by 2018 and makes this conditional on the strict application of a mine closure program that generates losses. It can be estimated that the evolution of production costs, the extra costs of CO2 emissions and the abolition of subsidies on production (demanded by the EU) will lead to a further decrease in the competitiveness of the domestic production and the significant reduction of production.

Current oil reserves are estimated at 73.7 million tonnes and annual crude oil production dropped from 14.7 million tonnes in 1976, when production peaked to 5 million tonnes in 2006.

Also, natural gas reserves are limited, and after 1990, domestic production is declining. Current gas reserves are estimated at 184.9 billion m.c. Annual gas production was 12.3 billion m.c. in 2006, which accounted for 69% of the national annual consumption of total natural gas.

---

[110] *"Costin C. Kiriţescu" National Institute of Economic Research, Romanian Academy, Bucharest, Romania, PhD, email: raluca_dumitru1@yahoo.com*

[111] *Annex to Government Decision no. 1.069 / 5 September 2007, regarding the approval of the Romanian Energy Strategy 2007-2020, published in the Official Gazette of Romania, Part I, no. 781 / 19.XI.2007, in accordance with art. 4, par. (1) of the Electricity Law no. 13/2007, as amended and supplemented, chapter 3 (3.1). Lignite resources in Romania are estimated at 1,490 million tonnes, of which 445 million tonnes are exploitable in perimeter concessions. Resources located in new non-concessional perimeters are 1,045 million tonnes. Of the reserves of 1,045 million tons of lignite in Oltenia's mining basin, 820 million tons of new perimeters are located in the continuity of the concession perimeters, presenting the most favorable conditions for capitalization, by extending the concessions. Since the lignite deposit in Oltenia consists of 1-8 layers of exploitable coal, their superior valorization requires the urgent adoption of regulations that guarantee rational exploitation in total safe conditions (minimum losses) and in terms of efficiency.*

[112] *Idem. The known coal resources in Romania are 755 million tons, of which 105 million tons are exploitable resources in concession perimeter.*

The Romanian deposits are situated in complex geo-mining conditions and the mineralogical characteristics that influence the quality are at the lower limit. From an economic and energy perspective, for the production of electricity, indigenous honey without subsidies becomes a marginal source. According to the state of national primary energy resources, it is relevant that with the exception of renewable energy sources, lignite is the only primary source of primary energy resource that can significantly contribute to securing electricity consumption needs in the next 2-4 decades.

Existing and exploitable ore reserves ensure the demand for natural uranium up to 2018 for the operation of two nuclear power plants at the Cernavoda site[113].

Therefore, it is appreciated that the primary energy production in Romania is based on the exploitation of fossil reserves of primary energy, coal and hydrocarbons, and uranium ore, and in the most optimistic situation it will not increase in the next 20-30 years.

For this reason, the increase in the demand for primary energy in Romania will be possible by increasing the use of renewable energy sources and by imports of primary energy, gas, coal, crude oil and nuclear fuel. At the level of the analyzed horizon, our country will remain dependent on primary energy imports, the degree of dependence being influenced by the discovery of new exploitable domestic resources, the integration of renewable energy sources and the success of measures to increase energy efficiency.

According to the latest assessments, Romania's technically renewable hydropower potential is about 32,000 GWh / year. At the end of 2009, the power installed in hydroelectric power stations was 6,450 MW, the energy for the average hydrological year being estimated at 17,340 GWh / year. Thus, at present, the degree of utilization of the technically feasible potential is 54%.

With the exception of large hydropower plants, the costs of producing electricity in units using renewable sources are now higher than those related to the use of fossil and nuclear fuels. Stimulating the use of these sources and attracting investments in energy units using renewable sources is done through support mechanisms, in line with European practice, which also lead to an increase in the price of electricity to the final consumer.

The realistic potential of wind and hydroelectric power is substantially lower than the technically viable, due to environmental restrictions (sites with a ban on use), and it is useful to develop studies on the impact of wind turbines on bird migration, especially in the south-east of the country, the definition of a clear and unique map of areas where wind and hydroelectric units are not suitable for environmental reasons.

The use of renewable energy sources has a significant impact on the national electro-energetic system, being useful:

- studies on the impact of the take-up of electricity produced by wind turbines and cogeneration, using biomass in the transmission and distribution network (110 kV or higher), in areas with high potential;

- the development of distribution and transport networks in the concept of smart grid;

- the construction of new capacities for the production of electricity with increased flexibility in the operation and development of the capacity market to counteract and / or limit the negative effects of the uncontrollable variability of wind energy and micro-hydropower.

A key element of the energy strategy is the improvement of energy efficiency, which has an important contribution to achieving security of supply, sustainable development and competitiveness, saving primary energy resources and reducing greenhouse gas emissions.

The representative synthetic indicator on energy efficiency at national level is given by the energy intensity and the energy consumption for producing a unit of gross domestic product[114].

---

[113] Potential new perimeter uranium ore deposits can not significantly change this situation, which requires the adoption of specific measures to ensure natural uranium resources according to the needs of the nuclear energy development program.

Electricity intensity has evolved favorably, although it has fallen by 10%, almost twice as high as the European Union average.

Starting with 2003[115], account is also taken of the economic potential of increasing energy efficiency in different sectors. As a result of this strategy, it was established as a strategic objective in Romania the improvement of energy efficiency throughout the chain: natural resources, production, distribution, transport and final use, using optimal market economy mechanisms until 2015 a decrease of about 3% per year of energy intensity on the national economy as a whole.

Improving energy efficiency[116] is one of the most important strategic objectives for Romania, given that in the structure of the national economy and in particular the industry there are still activities that use the energy resources as raw materials, mainly petro-chemistry and the chemical fertilizer industry[117].

The economic development as a whole, increasingly centered on the machinery and service industry, will lead to a decrease in the share of energy intensive activities over time.

Evolution of production and consumption of energy

Domestic primary energy consumption grew by 8.2% between 1999 and 2008, a lower percentage than GDP growth over the same time span (23.9%)[118]. Due to the low level of economic development, the gross energy consumption per inhabitant (1.8 tep / person) in Romania is about twice as low as in the European Union countries.

The beginning of the phenomenon of decoupling the increase of the energy consumption from the economic growth is also registered in Romania, a phenomenon which in the developed countries has been recorded since the first oil shock. At the same time, due to the economic restructuring and the improvement of the energy use, it is also noticeable in Romania the decoupling of GDP growth from the increase of the gross consumption of energy.

The primary energy consumption is balanced between natural gas (36.4%), crude oil and petroleum products (24.2%), but also between coal and coke (23%).

Economic development, economic structure and energy efficiency measures are the main factors influencing domestic consumption of primary energy. The main restriction is the limited nature of internal fossil fuel resources and the tendency to diminish domestic production, leading to increased dependency of any country on primary energy imports.

In Romania, domestic energy production remained virtually constant at about 27-28 million teps due to the limited reserves of primary energy resources. Without the contribution of renewable energy sources, this value will gradually diminish in the coming years.

Taking into account the high costs of capitalizing on renewable sources, it is unlikely that in the medium term the increase in primary energy consumption and the diminution of domestic

---

[114] Annex to Government Decision no. 1.069/5 September 2007. The structural adjustment of the economy, as well as the increase in resource efficiency, led to a reduction in the primary energy intensity from 0,605 tep/1000 Euro in 2000 to 0,492 tep/1000 Euro in 2005.

[115] Government of Romania, National Strategy for Energy Efficiency, Bucharest, 2003-2017

[116] Government of Romania, National Action Plan for Energy Efficiency (2007-2017), Bucharest, 2017

[117] Annex to Government Decision no. 1,069 / 5 September 2007. At the level of 2005, 94% of the amount of oil produced or imported was used in petrochemistry. If the import of crude oil is about twice the level of production and its share in the import of mineral products is about 57%, it results that the decrease of the specific consumption in this branch will have a significant positive impact on the energy bill of Romania. In the case of natural gas, consumption as raw material in the chemical industry accounts for about 35% of the import. If the direct consumption of metallurgy (as an energy resource) is added, it can be estimated that about 50% of the natural gas imports is conditioned by the activity in these two branches.

[118] Idem. GDP in 2006 was 42.2% higher than in 2000, amounting to 3.973 euro / place, being about 6.3 times lower than the average value in EU countries and 1.9 times higher lower than the average of the 10 countries entering the European Union in 2004 (NM 10). This economic development led to an increase of only 4,3% of the gross domestic energy consumption in 2005 compared to 2000, and the value achieved in 2005 was about 37,9 million tep.

production will be fully covered by renewable sources, which will lead to an increase in primary energy imports.

Over the past decade, dependence on primary energy imports has continuously increased from 21.5% in 1999 to 27.2% in 2008, with a peak of 31.9% in 2007, the year before the onset of the economic crisis.

The representative synthetic indicator on energy efficiency at national level is given by the energy intensity and the energy consumption for producing a unit of GDP.

Due to the structural changes in the economy and the emergence of new energy-efficient economic units, the intensity of primary energy has decreased significantly in recent years.

On 1st January 2010, the power available in the power system was 17,693 MW. About 80% of the thermo-energetic groups in Romania were installed between 1970 and 1980, and nowadays the standard life is exceeded. The thermal power plant park has low performance due to the technologies of the 1960s and 1970s and physical wear[119]. Most of the thermo-power capacities are not yet equipped with efficient pollution abatement facilities, and SO_2 and NO_x emissions are above the maximum allowed values in the European Union[120]. In the last 10 years some thermoelectric plants representing about 10% of the installed power have been upgraded / refurbished and environmental compliance works are under way at most of the thermal power plants.

The heat supply in the centralized distribution systems is achieved through thermal power plants and district heating plants, but total heat consumption has decreased slowly over the last few years, mainly due to the decrease in industrial consumption[121]. At the same time, the current centralized heat supply systems are characterized by obsolete low-efficiency (co-generation) and large transmission and distribution losses (between 10% and 50% in some cases), generating high production costs and the distribution of thermal energy and the diminution of the quality of services and the increase of the energy bill for the population. As a measure of social protection of the population, in order to decrease the expenditures on housing maintenance, given the usefulness of reducing energy consumption at residential blocks, the Government of Romania adopted the Emergency Ordinance no. 69/2010 on the thermal rehabilitation of residential buildings, financed by government guaranteed bank loans and subsidized interest.

With an outdated standard life, the hydropower groups have an installed power of 6,450 MW (31% of total installed power). After 2000, production capacities of about 1,000 MW were rehabilitated through modernization and modernization. Unit 1 from Cernavodă NPP (707 MW) is in operation since 1996. In the second semester of 2007, the unit no. 2 from Cernavodă started its commercial exploitation, thus ensuring the doubling of the national electricity production of nuclear origin (20.3% of the total production).

Distribution networks have an advanced degree of physical wear (about 65%) of low, medium and high voltage (110 kV) power lines, transformer stations and transformer stations. Moral wear is added to this, with 30% of the installations being equipped with appliances produced in the 1960s. Its own consumption in distribution networks, including trade losses, as an annual average is well above the EU average of 7.3%.

Approximately 69% of the total length of the national gas transmission system is overdue. Of the total control and measurement stations, about 27% have been in operation for more than 25 years. Natural gas distribution networks are characterized by the increased wear and tear of pipelines and pipelines, approximately 40% of which have a normal life span.

---

[119] Idem. The yield is about 30%, except for some rehabilitated coal groups reaching 33%. These yields represent only 65-70% of the performance of modern groups, which are currently operating in most developed European countries.

[120] All the thermo-energy groups that remained in operation after 2014 must comply with the environmental requirements of Order no. 859 / 29.09.2005 of the Ministry of Administration and Interior. Failure to meet these groups' compliance with European Union rules by the indicated date will result in a ban on their operation after the expiry of these deadlines.

[121] Idem. In 2006 the total consumption of 9 million tep, of which the consumption assured through centralized distribution systems represents 2.6 million toe, respectively about 30%.

Underground storage capacity of natural gas has grown to about 4 billion cubic meters.

The national oil pipeline system has a transmission capacity of about 24 million tons / year. The transport capacity was used up to a maximum of 60%. The system has entered into a comprehensive rehabilitation and upgrading program since 1996.

According to the estimates of the National Institute of Statistics, 45% of Romania's population lives in rural areas, mainly engaged in agriculture or other rural activities. Although 98% of households benefit from electricity, only 7% of them are connected to natural gas distribution networks. Therefore, the main fuel used for heating and food preparation is biomass (wood, wood waste or agriculture), and 98% of households use stoves for heating. Only 2% of households are equipped with centralized heating systems, but they also use a large proportion of solid fuel stoves (biomass) to cook.

Uranium ore production has declined steadily over the past decade due to the closure of production capacities on the grounds of economic non-profitability or the depletion of geological reserves. This production was processed and refined to the uranium octoxide intermediate product.

As a result, the primary energy production in Romania, based on the exploitation of fossil reserves of primary energy, coal and hydrocarbons, and uranium ore, in the most optimistic situation, will not increase in the next period.

Energy consumers market

Recent developments in Central and Eastern Europe highlight the development of market-based models based on different options and the projects are not fully convergent. There is a diversity of views of the main stakeholders involved in the optimal solution for achieving market integration in this region. The national electricity markets in this region are characterized by varying degrees of maturity and liquidity levels.

The South Eastern Europe Energy Community Treaty (in force on 1 July 2006) aims at creating a regional, efficient and efficient electricity and gas market in South-Eastern Europe, closely linked to the European Union's strategy and vision[122].

In Romania, in 1996, it started the creation of functional markets for electricity and natural gas and was based on:

- restructuring of the energy sector by separating the production, transport, distribution and supply activities of electricity and natural gas;

- ensuring regulatory access to transmission and distribution networks, in conjunction with the progressive opening of the electricity and gas markets, thus fostering competition in energy and natural gas supply and production;

- creating the institutional framework for the regulation of the electricity and natural gas sectors;

- transposing the provisions of Directive 2003/54 / EC on common rules for the internal market in electricity and Directive 2003/55 / EC on common rules for the internal market in natural gas and the application of Regulation 1407/2002 / EC which refers to the operation of the European Union's free-market coal producers;

- the issue of related secondary legislation (wholesale electricity trade code, performance standards, technical codes, framework contracts etc.).

The signatory countries have pledged to implement the EU acquis on energy, environment, renewable sources and competition, with specific reference to compliance with the relevant EU legislation, and these countries have undertaken all appropriate measures to ensure the fulfillment of their obligations and the requirements of the Treaty.

---

[122] The EU started the liberalization of electricity markets in 1996 through Directive 96/92/EC and the gas Directive through Directive 98/30/EC of 1998. By Regulation 1407/2002/EC laid down the functioning of the coal extraction industry, under the conditions of the free market after 2011.

Romania has opted for the decentralized market for electricity and natural gas, in which the participants free-to-sell electricity-purchase transactions.

The electricity market consists of the wholesale market where electricity is purchased for resale and transactions are carried out between licensed producers and suppliers and, respectively, the retail market where electricity is bought for consumption, and transactions take place between suppliers and consumers of energy.

The regulation of activities having a natural monopoly (distribution and transport) was based on principles of transparency, non-discriminatory access to the network and recognition of justified costs. The regulated tariffs for the use of networks are calculated on the basis of the methodologies of the ceiling type since 2005.

In 2000, the electricity market started to open, and since 2005 all consumers, except households, have become eligible, which corresponds to a 83.5% opening of the electricity market. The full liberalization of the electricity market, including for domestic consumers, took place on 1 July 2007.

In 2005, the wholesale electricity market expanded and improved by introducing four new trading platforms: the next day market, organized and managed by the wholesale electricity market operator, the Opcom society; the balancing market, organized and managed by Transelectrica; the centralized market for bilateral contracts and the centralized green certificates market, organized and managed by the Opcom society[123].

This market model is adopted by all developed European countries. Since 2007, Romania was the only country in the region organizing a market for the next day and a functioning balancing market. Thus, in addition to trading through contracts, participants in the wholesale electricity market have the opportunity to participate voluntarily in a short-term physical energy market (the next day market) operated by the Opcom society. The balancing market is primarily intended to offset deviations from the programmed values of electricity production and consumption, making it mandatory for all available production capacities. The centralized and forward-looking bilateral markets ensure the transparency of bilateral contracting, while meeting the recommendations of the European Commission, the European Council of European Regulators and the World Bank for the establishment of a regional stock exchange contract.

Support for the production of electricity from renewable sources takes place through green certificates traded on the competitive green certificates market and mandatory quotas for suppliers. Each supplier has the obligation to acquire annually a quantity of green certificates, directly proportional to the amount of electricity sold to consumers by that supplier. Transactions with green certificates can take place within the centralized market operated by the Opcom society or by bilateral contracts. The Opcom society manages the Centralized / Bilateral Green Certificates Market and the Green Certificates Register.

Natural gas is produced by 98% by two companies, Romgaz and Petrom, while the remaining 2% is represented by other companies. Of the total national production, about 62.5% is extracted on the Territory of Mureş County.

The internal gas market is made up of the competitive segment, which includes the sale of natural gas between suppliers and between suppliers and eligible consumers, and prices are formed freely, based on demand and supply, and the regulated segment, which includes activities of a natural monopoly and supply at a regulated price based on framework contracts.

The price and tariff systems are set by ANRE in the regulated market segment based on their own methodologies[124].

Activities related to the regulated segment include:

- supply of natural gas at regulated prices and on the basis of framework contracts to consumers;

- administration of trade and contractual balancing of the internal market;

---

[123] *Romania's energy strategy project, Chapter 3, point 3.6, in http://www.adevarul.ro/financiar/Descarcati_de_aici_Proiect_strategiei_energetice_a_Romaniei_2011-2035_Draft_I_ADVFIL20110123_0005.doc, accessed on 26.04.2018*

[124] *Idem. Romania's energy strategy project.*

- natural gas transport;

- underground storage of natural gas;

- gas distribution;

- transit of natural gas, except transit through dedicated main pipelines (transit through dedicated main pipelines is subject to the regime established by international agreements on the basis of which they were made).

In order to ensure an organized framework for equitable and non-discriminatory allocation of natural gas from domestic and imported production, the market operator, organized within the National Gas Dispatch Center Bucharest, from the structure of Transgaz S.A. Medias.

In order to ensure the consumption needs of all categories of consumers and to eliminate the malfunctions occurring in the domestic gas market during 2005-2006 (in winter, due to the low temperatures and the decrease of the imported natural gas quantities in January and February 2006), the draft law transposing Directive 2004/67 / EC on measures to safeguard security of natural gas supply was drafted. The interruptible consumer contributes decisively to maintaining the full functioning of the National Gas Transmission System and Distribution Systems by accepting the reduction in consumption until it stops, according to the provisions of Directive 2004/67 / EC, in order to ensure the protection of the consumers' supply households.

With regard to the coal market, given the characteristics of the coal extracted in Romania (energy coal with a calorific value of 3,650 kcal / kg and lignite with a calorific value between 1,650 and 1,950 kcal / kg), it is assumed that the latter can be used only in thermal power stations equipped for this type of fuel and located as close as possible to the lignite suppliers. The coal supply to current producers in Romania is 33-34 million tons, a demand of about 5 million tons lower than estimated for 2010-2020. For the period 2013-2020 and after this period, the demand for lignite is conditional on the highlighting of existing perimeters, as well as research, for the relief and capitalization of new perimeters. At the same time, expropriation procedures for public utility reasons need to be improved to make lignite surface operations more efficient. Uranium ore resources available to Romania are of great interest to the national economy, taking into account the operation of Units 1 and 2 of Cernavodă, but also a future development of the nuclear energy program, which is why the operation and preparation uranium ores and refining of technical concentrates is of strategic interest.

The uranium ore produces the sinterable material of uranium dioxide powder, which is used in Romania for the manufacture of nuclear fuel destined for the nuclear power plants of Cernavodă[125].

Romania does not have a uranium market, the only supplier being the National Uranium Company, and the price is negotiated between the supplier and the user, namely „Nuclearelectrica" National Company S.A.

In order to ensure the raw material for the production of nuclear fuel, useful for the operation of the two nuclear power plants, but also for the functioning of units 3 and 4 in perspective, it is necessary to take the risk of opening a new national production capacity and to provide a useful legislative framework worldwide for uranium ore concessions in order to exploit or import uranium ore deposits or technical concentrates. Globally there is a highly developed uranium market with a high degree of stability, with significant uranium reserves in conflict-free geographical areas.

Conclusions

In conclusion, with regard to exhaustible energy resources, a correct assessment of the possibilities to meet the needs of primary energy resources in perspective must start from the current situation of safe reserves, correlated with a realistic estimation of potential resources and in close interdependence with the consumption forecasts of resources determined by the demand for final energy.

---

[125] *http://www.economica.net/centrala-de-la-cernavoda-are-un-nou-furnizor-de-uraniu-cameco-inc-din-canada-totul-despre-aceasta-firma_115230.html*, *accessed on 27.04.2018*

Primary energy production in Romania is based on the exploitation of fossil reserves of primary energy, coal and hydrocarbons, and uranium ore, and in the most optimistic situation it will not increase in the next 20-30 years.

Bibliography

Câmpeanu Virginia, Pencea Sarmiza, Renewable Energies - Where To? Between the „myth" and the post-crisis realities in Europe and Romania, University Publishing House, Bucharest, 2014

Cosma Dragoş Ionel (coord.), Renewable Energies, Pax Aura Mundi Publishing House, Galaţi, 2015

Dobrescu Emilian M., Dobre Edith-Mihaela, Dumitru Raluca-Ana-Maria (coordinators), „Renewable energies. Economic and Social Efficiency", „Sustainable Development and Renewable Energies", National Economy Institute and "Costin Murgescu" Institute of World Economy from the "Costin C. Kiriţescu", National Institute of Economic Research of the Romanian Academy, revised, BILTONG Publishing House, Bucharest, 2013

Ioan Sorin, Energy Security - Priority on the NATO and EU Agenda in „Romanian Military Thinking", no. 3, May-June 2008

Decision of the Romanian Government no. 1.069/5 September 2007, regarding the approval of the Romanian Energy Strategy 2007-2020, published in the Official Gazette of Romania, Part I, no. 781 / 19.XI.2007, in accordance with art. 4, part. (1) of the Electricity Law no. 13/2007, as amended and supplemented, chapter 3 (3.1)

Directive 96/92 / EC on the liberalization of electricity markets

Directive 98/30 / EC on the liberalization of the gas market

Government of Romania, National Action Plan for Energy Efficiency (2007-2017), Bucharest, 2017

Government of Romania, National Strategy for Energy Efficiency, Bucharest, 2003-2017

Rule no. 1407/2002/EC on the functioning of the coal extraction sector under free market conditions

Romania's energy strategy project, Chapter 3, point 3.6, in http://www.adevarul.ro/financiar/Descarcati_de_aici_Proiect_strategiei_energetice_a_Romaniei_2011-2035_Draft_I_ADVFIL20110123_0005.doc, accessed on 26.04.2018

http://www.economica.net/centrala-de-la-cernavoda-are-un-nou-furnizor-de-uraniu-cameco-inc-din-canada-totul-despre-aceasta-firma_115230.html, accessed on 27.04.2018