ENERGETIC EQUIPMENT IN THE ROMANIAN TISA CATCHMENT AREA

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ABSTRACT – The article presents the context of energetic equipment in the TICAD area, traditional and alternative sources of energy, and includes a short presentation and the possibilities of use for each of them.

Keywords: electricity transmission networks, geothermal energy, solar energy, wind energy, biomass

TRADITIONAL ENERGY SOURCES

Short historical presentation

The studied area in the TICAD project includes the North-West, West and Centre Development Regions, the counties of Alba, Arad, Bihor, Bistrița-Năsăud, Cluj, Harghita, Hunedoara, Maramureş, Satu Mare, Sălaj, Sibiu and Timiş, respectively.

Although there were tight links with the other Romanian provinces, the industrial development was different in this area because of the difficult conditions in crossing the Carpathians by the means of communication: road, rail, networks (electricity, pipelines, communication lines, etc.).

Because of the administrative separation between Transylvania and the Old Kingdom (Moldavia and Wallachia), the development of the energy sector was different for the two state entities until after World War I.

Exploitation of methane gas in Transylvania began in 1909, while in Bucharest methane gas was introduced in 1943.

After natural gas was first found in Europe in 1909, in Sărmăşel (Mureş county) and, after drilling other wells with favourable results, our country has created the premises for a new industry in Romania, carrying out activities organized in harvesting the natural gas (gas both from the exploitation of methane gas and from the petroleum gas associated to oil exploitation).

The first industrial gas production was recorded in 1913 and was of 113,000 m^3, Romania being thus the first region in Europe with natural gas consumption.

Except some networks for petroleum and petroleum products, with reduced length and local importance, in Transylvania there are no such networks. The only connections with the refineries in Ploieşti area were built only up to Braşov.

Until after World War II, every important settlement had its own electrical power plant that produced electricity with specific characteristics (alternative, even continuous, 380V, 220V, 120V). Electricity transmission lines of max. 110kV were rare throughout the country.

An action to unify the security systems of electricity and natural gas began after World War II.

Transmission of natural gas has grown radially from the centre of Transylvania (mainly Mureş and Sibiu counties) to large consumers in the South (Bucharest, Craiova), West (Timişoara, Arad), East (Oneşti, Iaşi, Galați) so that there is a uniform coverage throughout the country.

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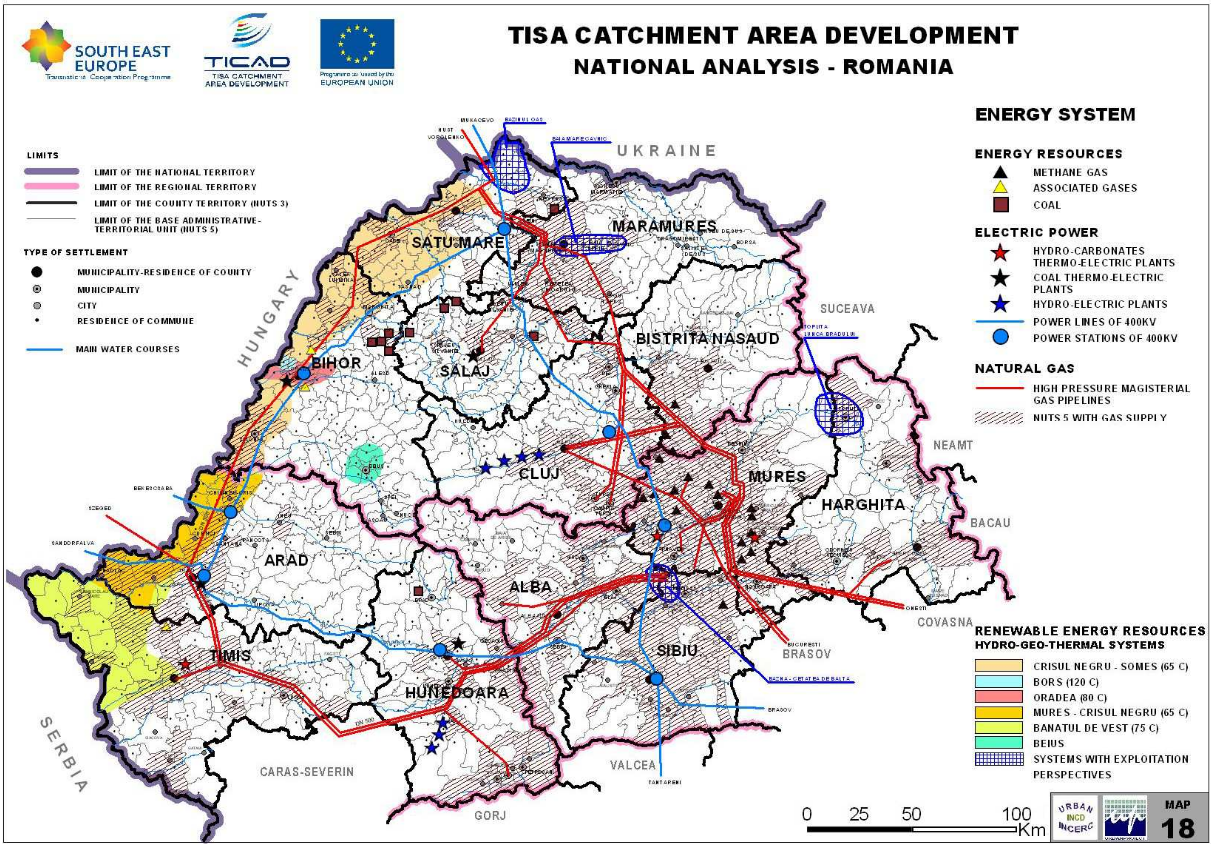

Figure 1. *The energy system in the Romanian Tisa Catchment Area*

Main routes

Electricity transmission networks have begun to diversify in terms of voltage use (220kV, 400kV, 750kV), linking thermal and hydroelectric power plants to primary consumers (large cities, former industrial sites), but also in terms of electricity supply to retail customers, except customers in isolated mountain villages.

The main power plants in the studied area are in Mintia, Iernut, Fântânele (power plants) and hydroelectric power plants on the Someşul Cald river (Mărişel, Tarniţa, Someşul Cald, Gilău, Floreşti), on the Crişul Repede river (Aştileu, Lugaşu, Tileagd), on the Sebeş river (Gâlceag, Şugag, Săsciori), Râul Mare, Sadu, Colibiţa. In addition, thermal power plants are operating in Arad, Oradea, Timişoara, Reşiţa, Paroşeni.

All these power plants are interconnected both between themselves and with other power plants in the country through aerial electric lines of 110kV, 220kV and 400kV.

Key areas of interconnection are the hydroelectric power plants (HPP) Porţile de Fier-Reşiţa-Timişoara-Arad-Oradea-Roşiori-Baia Mare and Satu Mare, the power plants Rovinari-Mintia-Alba Iulia-Cluj-Napoca-Zalău-Baia Mare, Arad-Mintia, Iernut-Baia Mare, Câmpia Turzii-Fântânele-HPP Stejaru (Bicaz).

Thus, the northern Carpathians are not crossed by major power supply networks, mainly because of the mountains, but also because of the lack of cities with large consumers of electricity. Crossing this area is expected to be achieved by aerial electric line Gădălin (Cluj county) - Viişoara (Bistriţa-Năsăud county)-Suceava-Bălţi (Moldova).

The main lines of interconnection with neighbouring countries are Arad-Sandorfalva (Hungary) (400kV), Roşiori-Munkacevo (Ukraine) (400kV) and Jimbolia-Kikinda (Serbia) (110kV).

The 400kV Nadab (Arad county)-Békéscsaba aerial electric line is currently put into use, while the aerial electric line Săcălaz (Timiş county)-Novi Sad is currently under design. These links are disproportionate to the south of the country: Porțile de Fier (Mehedinți county)-Djerdap (Serbia), Țânțăreni (Gorj County)-Kozloduy (Bulgaria), Isaccea (Tulcea county)-South Ukraine, respectively Vulcaneşti (Republic of Moldavia), Negru Vodă (Constanța county)-Varna, Dobrudja (Bulgaria), respectively.

The aerial electric lines in the studied area are optimal in terms of possibilities of exploitation, maintaining and voltage amplifying. The most important actions are to maintain them in good condition, to assure their monitoring and, especially, to assure the modernisation of the electrical transformer stations and their adaptation to the dispersed location of today's consumers (unlike the period before 1990 when large consumers were concentrated on major industrial platforms, the utilities being brought there).

The interconnection of the national power systems of Romania and of the neighbouring countries and, through them, with those in Europe, leads to an efficient energy market, with sustainable development, in accordance with the European Union standards regarding the efficient use of energy and the environmental protection.

RENEWABLE ENERGY SOURCES

Geothermal energy

The source of geothermal energy is the energy stored in the earth's crust and is highlighted by a gradual increase in soil temperature quantified by the thermal gradient. The global average geothermal gradient is Gt = 3K/100m.

The Romanian underground has large areas where geothermal gradient is higher than this value, the maximum value in Romania (more than 7K/100m) being found in the north of the Western Plain.

If a given geological structure (sandy soils, limestone, cracked sandstone) contains water, this takes the rock temperature, having, thus, the premises for valuing geothermal energy by drilling.

Geothermal water temperature has values ranging between 50-120°C, while the depth of aquifers has values between 1 and 3km.

About 70 geothermal systems have operational wells in Romania.

The table below comprises the main characteristics of the hydro-geothermal systems of the western part of the country:

Table 1. *Main characteristics of the hydro-geothermal system in the TICAD area*

Hydro-geothermal system	The average depth of wells [m]	Average water temperature [ºC]	Average flow probe [l/s]	Total mineralization of water [mg/l]
Crişul Negru-Someş	1500	65	10	3…11
Borş	2800	120	10	8…14
Oradea	2800	80	12	1.…3
Mureş-Crişul Negru	1500	6	8	2.…5
Banatul de Vest	2000	75	10	3…11

For a more complex exploitation of geothermal waters, gradual schemes are used. For this purpose, the following uses are considered:

- heating of buildings, domestic hot water;
- agriculture: greenhouses, solariums, cultures of algae, fish breeding;
- balneology, recreation;
- combustible gas separation;
- chemical recovery: extraction of useful minerals.

The used exploitation scheme must take into account the geothermal water quality; in all hydro-geothermal water usage schemes, the use of this kind of water for heating systems (civil and industrial buildings, hot water consumption) is made in the first step of the serial consumers' chain. Except the conventional clean water, the geothermal water is not introduced into users' geothermal heating systems (hydraulic separation between primary and secondary circuits being done by heat exchangers).

The reinjection of the geothermal water into soil is required for environmental considerations (particularly in the case of polluted water) and for the preservation of the deposit.

The high temperature of the geothermal waters in the area of Oradea-Borş led, for the first time in our country, to the use of geothermal water for heating and directly as domestic hot water. The direct use was stopped after noticing significant deposits of salts on the equipments (due to precipitation of salts at lower water pressure than in the deposit) and a certain degree of radioactivity in these waters.

The use for balneology and recreation, along with the use for heating and domestic hot water is done in hotels with treatment facilities in Băile Felix and Băile 1 Mai, where the use schemes aim to lower the temperatures obtained at the head of the well to about 30°C at reinjection into the deposit.

Depending on the temperature of the geothermal water, the following schemes can be used:

- 30-50°C: solarium heating, heat pumps for heating and domestic hot water;
- 50-80°C: heating and domestic hot water, associated with a boiler for domestic and industrial users, as well as for greenhouses;
- temperatures above 80°C: heating in drying processes, heating and domestic hot water associated with a boiler for domestic and industrial users, as well as for greenhouses.

An example of such geothermal water use is the centralized heating system in Beiuş, where the approximately 1900 apartments are provided around 12,000-14,000 Gcal/year for heating and domestic hot water.

As far as **solar energy** in the area under consideration is concerned, the energy potential of the solar radiation varies from 1250 to below 950 kWh/m² per year; it depends, mainly, on terrain elevation, the highest values being recorded in the Western Plain, while the lowest values being recorded in the Apuseni Mountains and in Banat.

For the beginning, the solar energy can be used to prepare domestic hot water in summer; with the help of experience and improved equipment, solar energy can also be used for heating, electrical energy generation, technological processes, small scale industry.

An efficient solar sensor is used at least eight months a year. The sensors with vacuum tubes can also be used in winter, being more efficient than flat collectors are. During the warm sunny days of winter, the water can be heated to temperature necessary for taking a shower (around 35^{o}C).

Heating systems using solar energy can be divided into two main categories:

- passive systems, characterized by the fact that space heating is done naturally, without the intervention of mechanical means to cause the movement of heat;
- active systems that require the existence of mechanical equipment to produce movements that convey heat between the source and the heated space.

It should be noted that the systems using solar energy must be equipped with automated installation in order to exploit this energy fully, safely, and comfortably.

Solar energy can also be used to produce electricity using photovoltaic cells, solution with a great potential for local use. The existence of a diverse range of photovoltaic panels - that can be mounted on the ground, on the roof or integrated into the building (thin film photovoltaic cells coupled to the waterproofing membrane of the roof) - , a continuous decrease in the price of photovoltaic cells and also the increased capacity of electric energy storage in accumulators are favourable conditions for this type of energy to be used not just as advertising for agritourist ecological zones, but also to ensure decent living and education conditions in remote areas without electricity supply networks. The investments necessary in the medium and low voltage power lines and transformers could be made in photovoltaic systems, which could be placed in the custody of users whose interest would be to maintain them in good condition.

In this context, the project in Jebel, Timiş county should be mentioned: 9,500 solar panels to be installed on almost 6 hectares. It is estimated that 2.8 million kWh/year are to be produced to supply electrical energy to the City Hall, school, police and for public lighting.

As regards the **wind energy**, for a profitable use, there should be an average wind speed of more than 3.5 m/s (optimum wind speed is at least 4 m/s) at the standard height of 10 meters above the ground (level where the measurements are done in weather stations); areas with lower average wind speeds, of below 2 m/s, do not present interest in terms of wind energy.

In the Romanian Tisa Catchment Area, the annual average wind speed is about 4 – 6 m/s in the Western Plain and about 3 – 4 m/s in the Transylvanian Plateau, with isolated areas of 6 – 9 m/s on the peaks of the Apuseni Mountains.

It is worth mentioning that the energy produced this way has higher costs than those of the traditional power generation. Maintenance costs make wind energy more expensive, and functioning at lower speeds significantly reduces the installed power. However, there are costs that the investor does not take into account when implementing such a project, for example the need to provide a power reserve. Building a wind power system involves network development costs, increased volumes of power reserves, costs for the new paid activities towards the energy transportation operator, costs due to the increased volume of imbalances in the National Power System.

It should be noted that, for the studied territory, the areas with wind energy potential are far from the zones with electrical infrastructure and high electricity consumers; therefore, the use of wind energy seems, on short and medium term, more suitable for local use, especially in remote areas.

As for **biomass**, its use refers also to burning the firewood and agricultural residues, considered a recoverable energy source.

The biomass that can be used for heat production can be wood chips, bark, crop residues, sawdust, cutting waste, forest residues, corn stalks, sunflower stalks, etc.; seed husks and even corn kernels can also be used. Special attention should be paid to the sawdust resulting from cutting and shaping wood, which can be sintered to result pellets of wood that can be used for combustion in special containers; the advantage is the lack of explosion hazard which should be posed by burning sawdust. Fuel storage and rhythmic, automatic feeding lead to a functioning with a higher degree of safety with a minimum time of burning.

Digesters, another way of using biomass, are not widely used for the moment; having such a device in an individual household, involves substantial investment, additional space, protection distances, but also a relatively small production of combustible gases that can only be used for small preparation of food (which can be replaced by using gas cylinders or even electricity). This kind of investment and gas production becomes profitable on large farms that grow livestock or poultry or where there is a great amount of agricultural waste that cannot be used for other purposes.

A peculiarity for the energy consumers, at the moment and even for short and medium term, is the fact that they are dispersed, they consume ever more personalized in terms of equipment and parameters; this involves stable energy sources, with the possibility of adapting to high consume variations and of easy adjustment possibilities. Such conditions can be ensured by using electricity and natural gas.

Linking sources and consumers of electricity and natural gas within national transmission and distribution systems and their interconnection with the systems in neighbouring countries would be very favourable in terms of needs, constancy of parameters, etc. However, this would create a greater responsibility, because a minor deficiency can lead to major disorder in national or even regional systems.

Regarding the use of renewable forms of energy, it should be noted that there is a high degree of unpredictable and only very rarely the generation of energy coincides, at the requested parameters, with the energy demand; this leads to the need to transform the obtained parameters, to accumulate energy and to link with spare or peak sources.

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