TRENDS IN THE USE OF ENERGY RESOURCES IN ROMANIA

SORIN MIHAI RADU[1], NICOLAE ILIAŞ[2], BOGDAN-CRISTIAN POPOVICIU[3], AURELIAN HORIA NICOLA[4], TIBERIU IACOB-RIDZI[5]

Abstract: This document explores the challenges and strategic directions regarding energy resource use in Romania and the European Union, with a focus on the period leading up to 2030. The analysis highlights Europe's increasing dependence on external energy resources, recognizing the impracticality of achieving energy self-sufficiency. Trends in energy consumption, production constraints, and resource depletion are examined, with particular emphasis on oil, natural gas, coal, and uranium. The restructuring of coal-based energy sectors, especially in Romania, is discussed alongside measures to enhance competitiveness and sustainability. Strategic national directions for natural resource use in Romania emphasize sustainable development, technological innovation, and alignment with global plans. Key insights include the necessity for long-term planning, investment in infrastructure, and the promotion of renewable energy to mitigate dependency and ensure future energy security.

Keywords: energy dependence, renewable energy, resource depletion, coal industry restructuring, sustainable development.

1. CONCEPTUAL ANALYSIS OF ENERGY RESOURCES

The future economic growth of Europe is characterized by energy dependence, and by examining the conceptual relationships in the field, it is estimated that by 2030, ensuring the self-sufficiency of Europe's energy resources, including those of Romania, will be practically impossible.

[1] *Prof. Ph.D. Eng., University of Petroşani, sorin_mihai_radu@yahoo.com*
[2] *Prof. Ph.D. Eng., University of Petroşani*
[3] *Ph.D. student Eng., University of Petroşani / Cuprumin Abrud, bobi_cn@yahoo.com*
[4] *Lecturer. Ph.D. Eng., Ec., University of Petroşani*
[5] *Ph.D. Eng., Petrosani Mayor's Office*

The most favorable recommendation is to operationalize the reduction of risks associated with the lack of adequately substantiated energy resources (see Fig. 1).

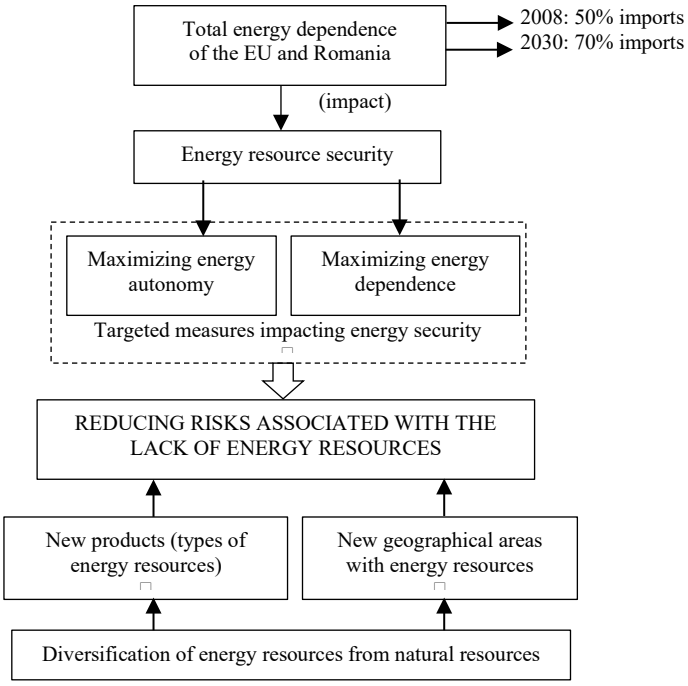


Fig. 1. Concept of risk reduction associated with the failure to ensure energy resources from natural resources in a United Europe by 2030

Since 1986, the annual growth rate of absolute energy consumption in the EU has ranged between 1-2%, and in the medium term, the absolute growth rate is expected to reach 3-6%, driven by modernization projects in member countries. This proves that in the EU, including Romania, the economy is still characterized by intensive energy consumption. Measures to transition to a European service-based economy have contributed to a 16% reduction in oil dependency, but consumption has shifted structurally to natural gas and electricity. For Europe, the outlook for 2030 shows that energy consumption will primarily occur in the tertiary and household sectors.

2. TRENDS IN ENERGY RESOURCE PRODUCTION

Analyses show that oil reserves are irregularly distributed across global deposits, and the EU does not significantly possess such resources. Only 4.4% of global production is found in the North Sea area, which is depleting.

Currently, the cost of extracting a barrel of oil in Europe is $7-11, compared to $1-3 in the Middle East. The forecast structure for energy production from fuels by 2030 acknowledges the natural limitation of the EU's energy resources and the uncertainty of developments in domestic hydrocarbon production.

The European Union's natural gas reserves represent only 2% of the world's total, ensuring domestic production for a maximum of 20 years at the current extraction rate. In absolute terms, global solid fuel reserves are 4-5 times larger than oil reserves, providing security for at least 200 years.

Approximately 80% of fossil fuels in the EU are solid fuels (coal), but their quality varies, and extraction costs are high. In the region, coal production accounts for 5% of global extraction.

Coal production costs in Europe are 3-4 times higher than the international market price ($150/tce compared to $40/tce). Consequently, restructuring measures in the European coal industry focus on technological corrections in exploitation to achieve competitiveness.

The EU holds only 2% of the world's uranium reserves, around 2.5 million tons, ensuring consumption needs for 40 years at the current demand rate. European reserves are depleting, and uranium mines in France, Portugal, and Romania are gradually closing and undergoing ecological rehabilitation.

Renewable energy resources are abundant, but their role (hydropower, biomass) remains limited in the European production and consumption structure.

The expansion of EU dependence on all forms of energy is practically driven by objective formulas for competitive action in coal, oil, and natural gas price formation, where markets and cartels play decisive roles (see Fig. 2).

It is estimated that by 2030, the EU's dependencies will manifest as 55% for oil from the Middle East and 42% for natural gas from Russia.

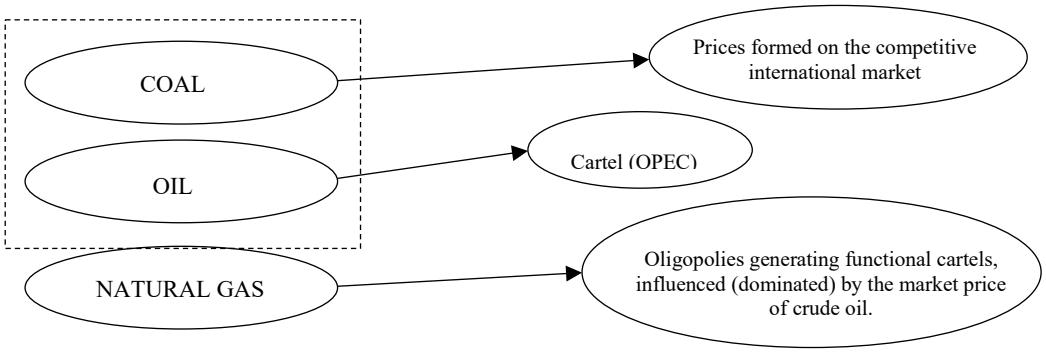


Fig. 2. Diagram of competitive action formulas for global coal price formation by 2030

3. STRATEGIC DIRECTIONS IN THE USE OF NATURAL RESOURCES

Romania's national strategy for the use of natural resources (see Fig. 3) outlines government, institutional, and public sector management approaches.

The goal of the strategy and its action directions is to promote sustainable development, including in the energy sector.

The key conditional elements for shaping energy resource use, based on specific strategies in Romania, must include analyses and quantifications related to: intensive use of raw materials and energy in national and European production; demand in production and consumption processes; the impact of transport and distribution on production and consumption; obtaining materials and energy from waste; and achieving higher quality levels for materials and productive-economic processes.

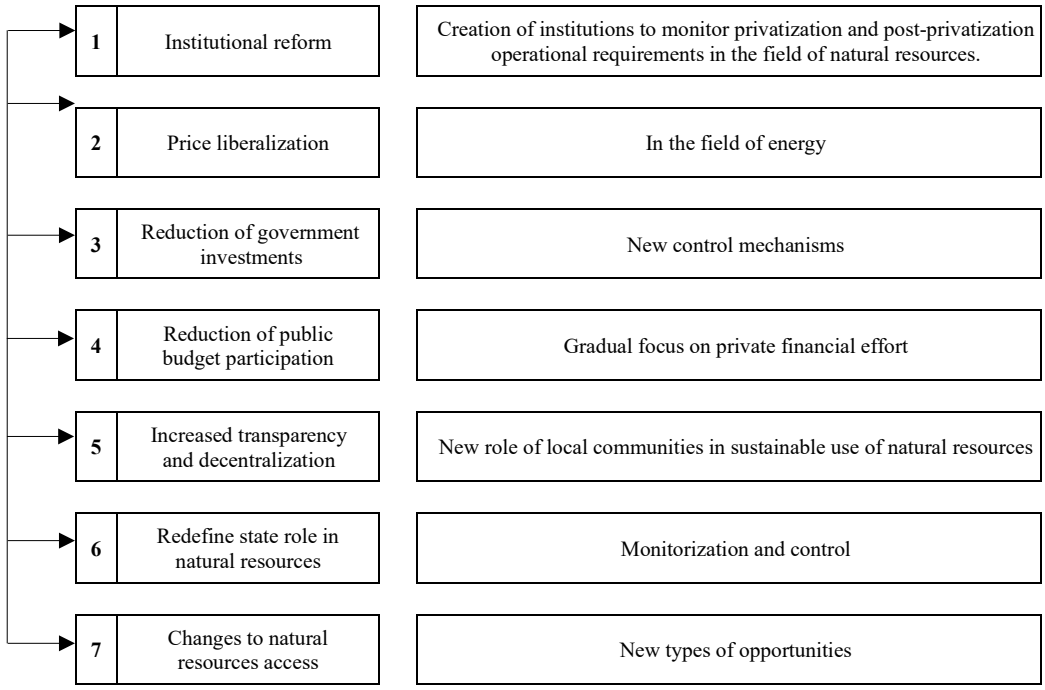
It is considered necessary that Romania's National Local Plan for natural resources aligns with the Global Plan.

For Romania, it is important to develop long-term visions in this domain, covering 25-30 years. Research on the introduction of new technologies into important infrastructures of the global production system should focus on the following periods: hydropower plants - over 75 years; construction - over 45 years; thermal power plants - over 45 years; nuclear power plants - over 55-60 years; gas turbines - over 25 years; vehicle engines - 12-20 years.

Currently, Romania's natural resource policy does not demonstrate the expected operational efficiency when measured against competitive targets.

Thus, there is a need to enhance the operational capacity of current measures in the field of natural resources, as well as to increase the operational capacity of the national policy currently applied in the natural resource sector.

In this regard, returning to the analysis of productive chains is recommended to obtain feasible diagnostic elements (see Fig. 4) by quantifying the main raw material and material flow policies.



a) Strategic directions b) Actions

Fig. 3. Diagram of strategic public, institutional, and government management directions for natural resource use in Romania

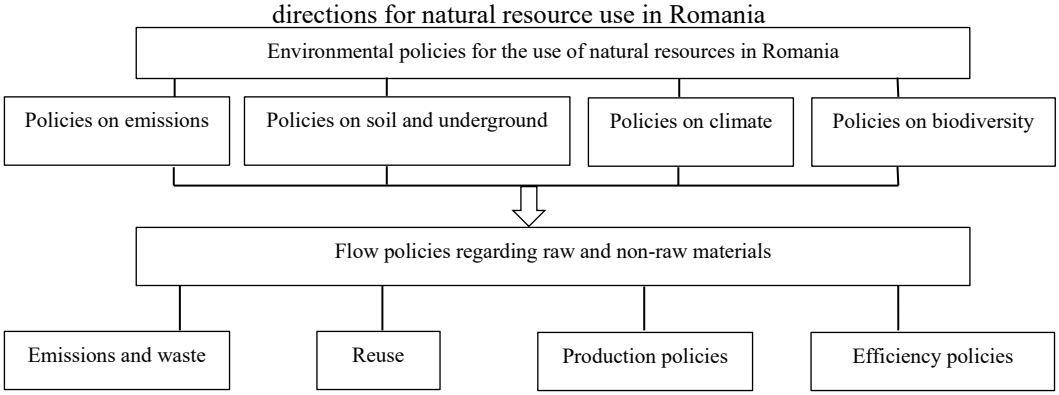
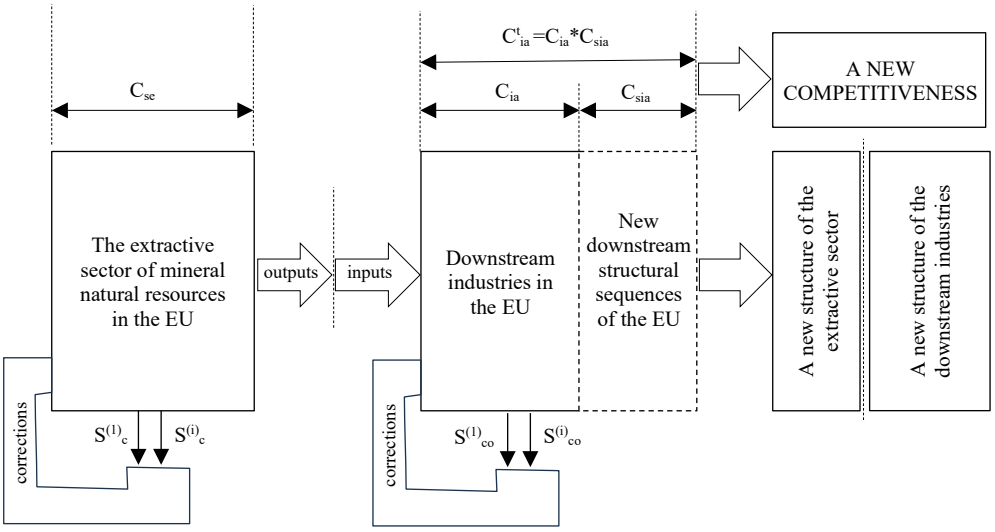


Fig. 4. Proposed policies in the natural resource domain in Romania

4. OUTLOOK FOR EFFICIENT USE OF NATURAL RESOURCES IN ROMANIA AND THE EU



Legend: C_{sc} – competitiveness of the extractive sector; C_{sia} – competitiveness of downstream industries;
C^t_{ia} – composite competitiveness of downstream industries;
$S^{(1)}_c \cdots S^{(i)}_c$ – critical situations (+/-) in the extractive sector;
$S^{(1)}_{co} \cdots S^{(i)}_{co}$ – critical situations (+/-) in downstream industries.

Fig. 5. Scheme targeting the achievement of a new structure for the extractive industry of mineral natural resources and new competitiveness in Romania and the EU

In the EU and Romania, the extractive sector of mineral natural resources must adapt to transformations, driven by competition, and align with the following main methodological directions (see Figure 5):

- selecting indicators and defining the competitiveness of mineral resource-based industries, from extraction to valorization;
- formalizing the structure and economic importance of downstream industries in the extractive mineral sector;
- identifying domain-specific parameters that may affect European competitiveness;
- critically assessing the current situation in the mineral natural resources sector in Romania and the EU and establishing new directions for action.

The competitiveness of the extractive industry of mineral natural resources is defined as the measure of a region's ability to attract firms from the resource extraction sector, encouraging them to invest or conduct activities over an extended period.

To measure competitiveness, the following quantifications are considered: the fundamental characteristics of the extractive mineral resource sector in each EU country; estimation of performance indicators of competitiveness; evaluation of price competitiveness; and guiding developments in productivity levels.

5. COAL-BASED ENERGY SECTOR IN ROMANIA

Romania's coal mining sector is undergoing a restructuring process to adapt to the market economy, align with the general and sectoral policies of the EU, achieve the country's global socio-economic balance, and ensure Romania's energy security in the context of sustainable development.

From an organizational perspective, restructuring has resulted in the transformation of autonomous administrations into national companies and the creation of energy complexes.

The third stage of organizational restructuring involves transforming coal-producing units into joint-stock companies.

All technical and organizational measures undertaken through the restructuring process aim primarily at cost reduction and subsidy elimination.

In terms of technological infrastructure, the equipment in the lignite extraction sector is outdated, and maintaining its operation requires significant rehabilitation to improve performance.

Most of the equipment in hard coal mines was manufactured under licenses from the 1980s, is physically worn out, inefficient, and prone to increased risks of failures and accidents due to insufficient modern monitoring, IT systems, and control tools in the exploited areas.

In addition to modernizing and renewing the equipment fleet and solving associated technological problems, it is necessary to adapt machinery to appropriate geological-mining technology, reduce downtimes through adequate maintenance policies, align equipment in production technology flows, adopt operational

management measures, increase production line flexibility, and adjust production capacities to demand variations.

The market economy in which coal production and integrated systems such as energy complexes operate requires a shift from quantitative, extensive performance indicators to global efficiency indicators. Maximizing these involves addressing human factors and analyzing the life cycle of equipment and technological systems, which play a decisive role.

6. CONCLUSIONS

Following the analysis of coal mining as a generator of energy resources in Romania, the following conclusions have emerged:

- Access to deposits is difficult, and prospecting and exploration activities are almost always costly.
- The European and Romanian legal frameworks governing extraction and exploitation of mineral energy resources are inadequate, restrictive, and closely tied to environmental conditions.
- Market access and competition are marked by technical and situational difficulties.
- Research and development in the sector still do not provide radical, high-resolution solutions to the sector's critical and inadequate situations.
- Industrial production costs based on natural resources are high, with limited possibilities for significant reduction.

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