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FACTORS AND INDICATORS OF THE GEOLOGICAL AND ECONOMIC ASSESSMENT OF THE COAL RESOURCES IN THE REPUBLIC OF SRPSKA AS THE STARTING BASIS FOR A DEPOSIT EVALUATION AS A FUNCTION OF THE NATIONAL AND COMMERCIAL PROFITABILITY

Abstract

The geological-economic evaluation of coal deposits in the Republic of Srpska includes two ways of evaluation the deposits: evaluation of coal deposits without taking the time factor into account (analysis the parameters of the static evaluation methods: economy and profit rate) and evaluation the three largest coal deposits (Gacko, Ugljevik and Stanari) with taking the time factor into account, evaluation the economic profitability (commercial and national). The following dynamic methods are used to assess the commercial profitability: Net present value, internal rate of return and cash flow discounting method for determining the return period of investments. The analysis of the economic effects of the investment project (assessment of deposit) is performed using a "cost-benefit" analysis. This analysis was performed using the following methods: NPV, IRR and DCFROI. As a part of the economic analysis, the analysis of the conditions of uncertainty is processed, i.e., sensitivity analysis of coal deposits, namely: static sensitivity analysis (determining the breaking point of profitability and critical price of a unit of mineral raw material) and dynamic sensitivity analysis, directed at the results of changes in parameters (income, costs, investments and legal obligations) to the changes in the calculated internal rate of return [2]. For the assessment of national profitability, the basic criterion of national profitability, net added value - NVA, is applied. In addition to the direct effects of coal production in the Republic of Srpska, on the national economy (financial income and expenses), the additional criteria were also analyzed: effects on employment, foreign currency inflow and international competitiveness, i.e., applying a "cost-benefit" analysis, an analysis of indirect effects is also performed (effects) of coal production on the national economy of the Republic of Srpska.

Keywords: geological-economic assessment, rating factors, rating indicators, national profitability, commercial profitability

1 INTRODUCTION

Geological-economic assessment of the coal resources includes:

- a) complex analysis of all factors;
- b) general expression of rating factors through one or more synthetic value indicators, with or without taking the time factor into account, and
- c) comparing the synthetic value indicators with individual value and natural indicators in order to establish the certain relationships, characteristic for the assessed deposit.

The geological-economic evaluation relies on a number of factors and indicators, which

* Mine and TPP Gacko

together represent a whole. Evaluation factors and indicators are used in all phases of the geological-economic evaluation, where in the preliminary exploration the phase natural indicators, derived from the appropriate factors, dominate, while in the detailed exploration phase of the deposit preparation and exploitation, the value indicators and factors, related to them, are of increasing importance.

2 FACTORS OF THE GEOLOGICAL AND ECONOMIC ASSESSMENT

The methodology of the geological-economic assessment of coal resources in the Republic of Srpska includes the analysis of the following assessment factors: mineragenetic, geological, legal, technical-exploitation, technological, regional, market, geoecological and social-political-economic-strategic.

2.1 Mineragenetic factors

The assessment of potential of a certain area, characterized by the specific mineragenetic characteristics, is carried out in order to single out the most favorable parts of the terrain in terms of possibility of finding the new coal deposits. The evaluation of potential in certain coal deposits in the Republic of Srpska was carried out on the basis of the results of a certain stage and type of geological explorations.

2.2 Geological factors

From the aspect of geological-economic evaluation the coal deposits of the Republic of Srpska, the geological factors, having a natural character, can be expressed through the economic type of the raw material, economic type of the deposit, morphological characteristics and degree of the concentration of reserves.

Coal, as the primary energy raw material in the Republic of Srpska, can be divided, according to the economic type of raw material into:

- a) Economic type of lignite coal raw material of Gacko and Stanari, and
- b) Economic type of brown coal raw material of Ugljevik and Miljevina.

According to the economic type, the coal deposits in the Republic of Srpska can be divided into three groups:

- a) Deposits of the primary economic type: Gacko, Ugljevik and Stanari;
- b) Deposits of the secondary economic type, Miljevina, and
- c) Deposits of the tertiary economic type: Majevičko, Tesličko, Lješljansko, Banja Luka, Mesičko, Bukovačko, Šipovsko, Omarsko and Kotor-varoško.

The coal deposits in the Republic of Srpska are layered, simple (Stanari) to the complex (Gacko, Ugljevik and Miljevina) structures.

2.3 Legislative and legal factors

Without the certain legal regulations, it is not possible to optimally manage the coal energy resources. The geological-economic assessment of the coal deposits of the Republic of Srpska from the perspective of legislation includes the analysis of [7]:

- Legislative-legal factor and exploration of coal deposits;
- Legislative-legal factor and exploitation of coal deposits, and
- Legislative-legal factor in the production and consumption of thermo-electric energy in the Republic of Srpska.

2.4 Technical-exploitation factors

The technical-exploitation factors of the geological-economic assessment of the coal deposits of the Republic of Srpska include the analysis of:

- Coal mine from the aspect of exploitation conditions, exploitation system, coal production and overburden excavation, losses and dilution during coal exploitation;

- Use of accompanying mineral raw materials/resources through the complex utilization of coal deposits in the Republic of Srpska.

Considering the coal mines in the Republic of Srpska, two groups of deposits are distinguished as the objects of coal exploitation:

- Deposits where coal is already or has been exploited (Gacko, Ugljevik, Stanari, Miljevina, Kotor Varoš, Lješljani and Ramići) and
- Deposits where it is possible to open the new mines (Majevica, Teslić, Mešići, Bukovica).

Starting from the fact that the coal deposits are the non-renewable energy resources with a limited life and that until 2013 the coal mines with surface exploitation (Gacko) were mainly exploited the coal seams with less stratification, and lately, by conducting the exploitation and detailed phase of geological exploration of the coal reserves of larger stratification, the expansion of the mineral-raw material base of the existing mine was done as well as increase of the exploitation life.

2.5 Technological factors

For assessment the quality of the raw material (coal), its calorific value has the greatest importance. The use of raw lignite in a lump form in wide and general consumption and industry is justified only within the economic radius of transport, because its calorific value is low. This means that by selling the pre-sorted raw lignite as a fuel in smaller urban settlements (closer to the mine), the positive economic effects would be achieved. The largest part of the raw lignite, produced in the Republic of Srpska, however, is used in the thermal power plants for the production of electricity. Technological factors of coal resources define:

- Technological type of raw material;

- Technological process of preparation, processing and use of raw materials, and
- Better thermal utilization of coal from the Republic of Srpska.

2.6 Regional factors

Regional factors play an important role in the geological-economic assessment of the coal deposits in the Republic of Srpska. In many cases, they significantly affect the economic indicators of the deposit being evaluated. The most important regional factors are: transport conditions, energy sources, climatic conditions, water supply conditions, and population.

2.7 Market factors

The market of mineral raw materials is specific in many characteristics compared to the market of the other industrial products. Market factors have an extraordinary effect on the geological-economic evaluation of the coal deposits of the Republic of Srpska and the achieved economic effects, as a result of the evaluation of deposits. Coal deposits in the Republic of Srpska are exploited in various, mostly difficult conditions, where the mines, with the current sales prices, operate at the limit of profitability. Although the planned predictions regarding the increase in production have not been realized, it can be stated that the surface exploitation is intensively developing, which in the current conditions provides significantly more competitive coal for the market. This is the result of investments, procurement of modern equipment and selection of more favorable deposits for this type of exploitation, that is, the opening of the new surface mines. The geologically and economically interesting for the future thermal energy planning are the coal mines, that is the lignite deposits, due to the cleanliness, less environmental pollution, low sulfur content, and due to significantly larger geological reserves. The mine locations are determined by the location of the deposits themselves.

2.8 Geological factors

The economic valorization of coal resources (exploration, exploitation, processing, post-exploitation period) results in the negative consequences for the environment. They are manifested in all spheres: earth, water and air [5]. Geoecological factors are especially important for the problem of coal resources of the Republic of Srpska: geoecological type of ore and deposits, changes in the state of the geological environment under the impact of geological exploration, exploitation and preparation of mineral raw materials, the impact of geological exploration, exploitation, preparation of mineral raw materials and accompanying processes on changes in the state of air, water, soil and plant and animal life, measures of recultivation and revitalization of the geological environment, geoecological condition of waste, possibility of using fly ash as the technogenic raw material, monitoring of the geological environment in the immediate vicinity of active coal mines, geoecological conservation of coal deposits, geoethical factors and their impact on evaluation the coal deposits, impact of infrastructural facilities on the geological environment in the immediate vicinity of coal mines, sustainable use and indicators of sustainable use of the coal resources, post-exploitation use of the open pits, pollution prevention measures in various process-work phases and environmental costs and their impact on profitability of the coal production [6].

2.9 Social-political-economic-strategic factors

Energy is an activity that has a significant impact on socio-economic development and environment. Therefore, it is the first area that should be established in the Republic of Srpska on the basis of sustainable development. The basis is the introduction of such economic incentives by the state, which will orient the producers and consumers of electricity towards increasing energy efficiency

applying not only technical but also the organizational measures. The state task is to introduce measures to increase the energy efficiency, enable entrepreneurs to keep their energy usage costs from rising. The state should monitor whether this has been achieved, by measuring every year:

- energy profitability (a measure of increase the economic profit in relation to the increase in the energy consumption),
- coefficient of price elasticity (a measure of reduction the energy consumption caused by the increased energy prices and supported by the economic stimulus of the state), and
- annual emission into the atmosphere of key pollutants (monitoring of the approach to obligations from the international agreements on the environmental protection).

The coal reserves proven so far, its quality, the existing capacities of the Gacko and Ugljevik mines and thermal power plants, as well as the capacities of the Stanari and Miljevina mines, are of great importance not only for the Republic of Srpska, but also for the surrounding regions. There are conditions to expand the capacities of both mines and thermal power plants, which would enable a long-term and orderly supply of electricity to the economy and population in a wider area.

3 INDICATORS OF THE GEOLOGICAL - ECONOMIC EVALUATION OF COAL RESOURCES IN THE REPUBLIC OF SRPSKA WITH THE METHODOLOGY OF DEPOSIT EVALUATION AS A FUNCTION OF THE NATIONAL AND COMMERCIAL PROFITABILITY

In the closest connection with the factors of geological-economic assessment, there are various indicators, which can be grouped into the natural, valuable and syn-

thetic. Indicators of geological-economic evaluation are the basis for a comparative analysis and selection the priority deposits for exploration and production activation, but they are also used in investment into the natural resources, long-term planning of the use of mineral resources, and then in determining the optimal investment options in the mineral economy. The process of geological-economic assessment of coal deposits can provide the useful data for the concrete expression of economic, social and socio-political effectiveness of geological explorations, specific analyzes of the current and future costs of such explorations, i.e., for a more complete overview and quantification the complex expressions of a mining rent.

3.1 Natural indicators

Considering the specificity of material being processed, a special attention is paid to the following natural indicators of geological-economic assessment: coal reserves of the Republic of Srpska, average quality of coal reserves, total energy potential of coal resources in the Republic of Srpska, production capacity and exploitation life.

Coal reserves with the average quality of reserves by deposits are shown with the balance on 12/31/ for the year in which the geological-economic assessment is carried out.

The following parameters are used to calculate the energy potential of the coal reserves of the Republic of Srpska, E (10^x Wh): m – mass of reserves (10^x g), mean lower calorific value (kJ/kg), conversion coefficient of the calorific value of 1MJ into the energy value of 1kWh.

The energy potential is calculated according to the following formulas:

$$E \text{ (MJ)} = m \text{ (} 10^x \text{kg)} \times \text{DTE (MJ/kg)}$$

$$1\text{MJ} = 1/3.6 \text{ (kWh)} = 0.2778 \text{ (kWh)}$$

$$E \text{ (} 10^x \text{ kWh)} = E \text{ (MJ)} \times 0.2778 \text{ (kWh)}$$

The exploitation life of the coal deposits (Gacko, Stanari and Ugljevik) is observed as a function of the amount of exploitation

reserves and planned production capacity according to the demand for energy fuel of current and planned thermal power plants. For other coal deposits in the Republic of Srpska, the exploitation life depends on the household demand and industrial consumption (mainly heating plants).

In the Republic of Srpska, coal (which is intended as the thermal energy fuel) is currently exploited at three active mines: Gacko, Ugljevik, and Stanari. The capacity of coal exploitation should be designed so as to provide the sufficient quantities of coal for a minimum of 25 years of operation (lifetime of the thermal power plant) plus 15 years after the revitalization of the thermal power plant (most of the placement of coal produced in active mines is planned for the thermal energy facilities) [1]. Since the exploitation life is aligned with the life of the thermal power plant, it is necessary to adjust the depreciation of the equipment at the mines to the duration of the thermal power plant operation. By increasing the amortization period, the amortization rate will decrease, and thus the cost of produced coal. One of the key elements of the financial/cost and investment assessment is the construction of the new thermal power plants, Gacko 2.

3.2 Value indicators

The analysis of value indicators as the important parameters of economic value of the deposit is performed on the basis of the financial effects realized in the coal mines of the Republic of Srpska in the previous year, with a projection for 2020, 2025 and 2030. Also, an analysis of the production and sales price of 1 ton of coal in the previous period of at least three years, with a projection for the period up to 2030, is carried out. Operating costs are planned for the period up to 2030 on the basis of the certain elements (regulations, workforce, maintenance, depreciation) [4].

Economic analysis of the active coal mines in the Republic of Srpska has the task of processing the information on relevant

economic facts. The analysis takes into account the business results from the previous period, and based on them, a business plan for the next period is drawn up. The analysis does not correct the business failures in the previous period, but creates the preconditions to avoid them in the future. These economic indicators, along with the economic analysis of the mine for the previous period with projections for 2020, 2025 and 2030, are necessary for the calculation of NPV and IRR [3].

3.3 Synthetic indicators

Synthetic indicators are the most complex indicators of the geological-economic assessment. Their main goal is to determine the economic (value) assessment of the mineral deposits. The economic (value) assessment of the coal energy resources of the Republic of Srpska includes:

- evaluation of the coal deposits without taking the time factor into account, and
- evaluation of the coal deposits taking the time factor into account.

For each investment project (deposit), determining the cash inflow and cash outflow in each individual year is not a simple operation. In the mineral economy, where the effect of exploitation is largely dependent on the natural conditions, this determination is even more complicated and carries a relatively high degree of uncertainty. The impact of inflation should be added to this.

3.3.1 Evaluation of the coal deposits without taking the time factor into account

In practice, the evaluation of a particular deposit or ore body is often expressed through the difference between the value of the useful components in the deposit (or those components that can be used from the deposit), and the costs that must be incurred to obtain them. The value of deposits and reserves of coal energy resources of the Republic of Srpska, without taking the time factor into account, which is done in the

current year, is shown with the state of December 31 of the previous year. The following formula is used to calculate the value of coal deposits in the Republic of Srpska:

$$V_u = (V_i - T_i) \times (R - G)$$

where:

V_u - conditional value of the deposit without taking the time factor into account (KM),

V_i - value of the useful components that the deposit contains (KM/t)

T_i - costs required to obtain the useful components (KM/t),

R - reserves of mineral raw materials in the deposit (t),

G - actual or planned losses of mineral raw materials (t).

3.3.2 Evaluation of the coal deposits taking the time factor into account

Exploration and exploitation of mineral deposits takes place over a certain period of time. The economic effects of exploitation also take place in a limited period of time and are subject to the effect of various impacts, depending on the length of exploitation life of the deposit, i.e., relationship between exploration works and production capacity. In principle, in a longer period of exploitation, it is realistic to expect a more pronounced effect of various risks, within which the geological, mining and economic risks dominate, and which must be taken into account in a certain way when calculating the economic (value) assessment of deposits and mines. Evaluation of the coal deposits of the Republic of Srpska, taking the time factor into account, includes the calculation of economic profitability, i.e., evaluating the commercial and national profitability of coal production from coal mines in the Republic of Srpska.

4 COMMERCIAL PROFITABILITY

The commercial profitability analysis is the first step in the economic evaluation of the project. It is concentrated on assessment the feasibility of a new project from the aspect of financial results. The direct bene

fits and costs of the project are therefore expressed in the monetary terms at prevailing expected market prices. This analysis is applied both to the evaluation of justification and acceptability of a project, as well as to the ranking of projects based on their profitability. Commercial profitability analysis includes: investment profitability analysis and financial analysis. These two types of analysis are complementary and not interchangeable. Both must be carried out as they focus on different aspects of investment evaluations. Analyzing the profitability of investment is the measurement of profitability the resources employed on the project, direct return on invested capital, regardless the forms of financing sources. Therefore, the analysis of profitability the investment is an assessment the potential returns of resources related to the project, regardless the financial transactions that occurred during the project life. On the other hand, the financial analysis takes into account the financial aspects of the project in order to ensure that the available financial resources in the future enable the easy implementation and operation of the project. The final assessment of commercial viability of coal production in the assessed deposits in the Republic of Srpska is carried out analyzing the economic effects that the project (assessed coal deposit) brings.

The following dynamic methods are used to evaluate the commercial profitability: Net Present Value, Internal Rate of Return and cash flow discounting method for determining the return period of investments. The analysis of the economic effects of the investment project (assessed deposit) is performed applying the "cost-benefit" analysis. This analysis was performed using the following methods: NPV, IRR, DCFROI [9]. As a part of the economic analysis, an analysis of the conditions of uncertainty is also carried out, that is, the sensitivity analysis for the coal deposits, namely: static sensitivity analysis (determining the break-even point of profitability and critical price of a unit of mineral raw material) and dynamic sensitivity analysis, which considers the results of changing

parameters (income, costs, investments and legal obligations) to the changes of the calculated Internal Rate of Return.

The dynamic methods (assessment the value of deposits taking the time factor into account) take into account the effect of time factor, that is, they start from the fact that money has a time value, and is determined by reduction the future economic effects of production using the appropriate discount rate on the day of assessment. Based on the input parameters, i.e., assessment of inputs (production, costs, investments, etc.) and expected results based on them (income, profit, etc.) for the period up to 2030, the net present value and internal rate of return are calculated for deposits with the active coal mines. Based on the current trends in coal prices in the previous period, the price of coal (KM/t) is planned and projected. Through the sensitivity analysis, we monitor the financial effects in the active coal mines are monitored, so the adopted price is only a starting point for further analyses.

5 NATIONAL PROFITABILITY

The analysis of national profitability is similar in form to the analysis of commercial profitability, since both try to identify the costs and benefits and, by their comparison, evaluate the profitability of the proposed investment [8]. A commercial cost-effectiveness analysis is the first step towards a national cost-effectiveness analysis. A country overall development strategy usually requires the fulfillment of several goals. Namely, it is necessary to evaluate the social validity of the project - from the aspect of effects on the economy as a whole, and through the special aspects of economic life in the context in which the project will be treated.

Consequently, in addition to the basic criterion - additional value as a way to evaluate the main impact of the project on the economy - a number of additional indicators are given to measure the certain implications of the investment project, such as: effects on employment, foreign exchange inflow and international competitiveness. For other imp-

lications that cannot be measured in the quantitative terms, a qualitative analysis with the additional consideration of the impact on infrastructure, technical know-how and environment is recommended. The final evaluation of the national profitability of coal production from deposits in the Republic of Srpska is performed by analyzing the results of the basic criterion of national profitability - net additional value and indirect impacts (effects) of coal production on the national economy of the Republic of Srps

6 FINAL CONSIDERATIONS

The strength of energy potential of the Republic of Srpska is based on balance reserves of coal which amount to ~700 Mt, potential reserves of oil which amount to 50 Mt and potential reserves of U_3O_8 of 6,000 t. The average coal quality of the balance reserves of the Gacko, Ugljevik, Miljevina and Stanari coal deposits is 11,300 kJ/kg. Coal from the Gacko and Ugljevik deposits is mostly used (about 95%) as an energy source for the production of electricity, while coal from the Stanari deposit is mostly used for the industry and household needs. Coal production in the active mines enables meeting the needs of households at the level of ~200,000 t/year. About 2,000 workers are employed in the active coal mines Gacko, Ugljevik and Stanari, and ~300 workers in the Miljevina mine. Investments in the Gacko, Ugljevik and Stanari coal mines [10] are mainly focused on the acquisition of mining equipment and machinery, and part of them on preparation the project documentation and preparatory activities for opening the new coal mines.

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