METHODOLOGY FOR PREPARING A STUDY ON LONG-TERM MINING

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Abstract: *Mining production brings with it a large number of issues related to its sustainability, such as techno-economic justification, adequate protection of the environment, realization of the interests of both the investor and the local community and the state, etc. Economic justification studies are done in the very initial procedure of awarding the concession, but it is necessary to do the same during the operation life of a particular mine, and they have the task of defining the conditions in an adequate, professional and substantiated manner and answering seemingly very simple questions: Who should do the work? What should be done? How should it be done (under what conditions)?*

In this paper, the methodology of a Study on Long-Term Mining is presented on the example of M&TPP Ugljevik, and Openpit mine "Bogutovo village East 1, respectively". The basic functions and goals of producing such a document are the definition of a long-term coal mining plan with projected annual quantities until the end of the mining life, adoption of a long-term concept of coal mining development with the harmonization of the schedule of works and the techno-economic conditions of mining works development, forecasting of necessary investment activities, creating conditions and final underlying instruments for accelerated development of contractor mining projects in the remaining mining life and finally defining the long-term mining strategy with measures and programmes to ensure stable and economically justified long term coal production.

Key words: TECHNO-ECONOMIC OPERATING CONDITIONS, STRATEGIC PLANNING AND DESIGN, PRODUCTION PLANNING, PRODUCTION PLANNING AND MINING SCHEDULE, SELECTION AND PLANNING OF MINING TECHNOLOGY AND ACTIVITIES, ECONOMIC AND FINANCIAL PROJECT ANALYSIS, ECONOMIC AND FINANCIAL PROJECT EVALUATION AND ENVIRONMENTAL IMPACT ANALYSIS

INTRODUCTION

Mining production therefore brings with it a large number of questions related to its justification and sustainability. Answers to the questions of techno-economic justification, adequate environmental protection, mutual realization of interests, both of the investor himself and of the local community and the state, are given by the preparation of economic justification studies, which increases the importance of the preparation of economic justification studies for a certain mining operation [1]. In the last few decades, the mining industry has become extremely "dependent" on geopolitical trends and the situation in some part of the world. This leads to many questions about the "expiry date" of the results of certain techno-economic analyses and evaluations of certain mining projects. Discount rates that take into account the time factor, but from the aspect of the specific characteristics of a certain mine location in terms of economic development, credit rating, economic growth, political and social risks of a certain country/state lead to insufficiently defined relationships between the economy, technical-technological solutions, geological and natural conditions, specific sociological and cultural circumstances. This is then solved by some generalized rules defined by geopolitics and not by specific conditions on the ground. The question arises as to what happens in situations of changing geopolitical trends and the existence of real possibilities, whether a deposit, which at a certain moment is unattractive from a techno-economic point of view, can suddenly be "transformed" into a very interesting deposit of mineral raw materials and vice versa. From a purely economic or market point of view, perhaps such an approach is justified, but bearing in mind that mining cannot be viewed only in that direction, it is necessary to find a way so that possible options and variants of the use of a deposit can be viewed and compared without the interference of geopolitical aspects and the ultimate protection of large mining companies.

In general, a different approach is needed in observations and assessments with a technical-technological, engineering perspective, respecting the basic principles of sustainable development and rational use of mineral raw materials (ultimately also fulfilling ESG standards). Definitely, on the one hand, there is the sales price, the market and issues of geopolitics as economic parameters, but on the other hand, there are also the quantities and quality of raw materials, "natural conditions", sociological, cultural aspects of looking at solving such issues, because they can greatly influence the overall "possible" level of investment in mining projects

The impact of a large number of factors (parameters of the working environment, mining technology, capacities and condition of equipment, locations of equipment and workforce, organization, efficiency and detailed operating costs of the system) requires an analysis of the possibility of applying a large number of technologies for mining useful mineral raw materials and overburden and complicates the management of systems mining. Maintaining optimal production values over time in changing conditions is a continuous optimization procedure, which must include all important and significant factors with the establishment of an applicable methodology [2].

The development of computer equipment enabled a fast and efficient way of creating certain models for optimizing production processes, managing the costs of the

technological process and reducing costs to a minimum, which implies fast, efficient and detailed collection of information for all segments, selection of the obtained information and decision-making that will in the given time give optimal results in order to reduce mining costs, which in turn give maximum profit [3]. Taking into account the large amount of information that circulates in the management systems and that can be of great importance in determining the optimal way and system of production, the need to create certain procedures and models for defining the future conditions of surface mining is indicated [4].

The goals of research in this paper are the structuring of important parameters that determine the basic techno-economic effects of the work of certain methods and mining systems, on the basis of which the future working conditions of a mine and specific moments of the working conditions, repectively, can be defined where the costs of the surface mining remain economically profitable with certain changes in production capacity, technology and mining system. The research includes conceptual setting of all necessary analyses and necessary decisions that need to be made throughout the life of mining along with monitoring the system's operation in real time with an assessment of its efficiency.

PRESENTATION OF THE PROCEDURE AND ACTIVITIES FOR PREPARATION OF THE STUDY ON LONG-TERM MINING

The creation of the concept and methodology of studies on long-term mining implies certain procedures for managing mining methods and the possibilities of replacing mining methods, which include, Figure 1:

- Analysis of the current state of the mine
- Adopting a long-term concept of mining development, by harmonizing the dynamic development of mining works and defining the priorities of subsequent activities. This is realized by using the basic conceptual design solutions from the valid mining project documentation, and by analyzing the achieved work results, taking into account the available data on the degree of exploration and balance reserves from the valid Survey,
- Defining a long-term operation plan with projected annual quantities until the end of the mining life, therby capturing all available reserves in the deposit. This includes an operation system plan with a choice of possible methods based on technical - technological experiences in terms of technical feasibility but also specific geological and working conditions, production capacity, type of mineral raw material and its possible market value, etc.).
- Defining the necessary infrastructure and equipment of the selected method,
- Selection of benchmarks (purchase prices, consumption norms, production capacities of machines in specific conditions and work organization),
- Defining the techno-economic conditions and predicting the necessary investment activity, which ensures the required level of production
- Analysis and determination of the structure and relationship between individual input and output data, i.e. results in terms of decision-making (all aspects of dynamic economic assessments of the project)

Figure 1, Concept of producing the Study of long-term mining

EXAMPLE OF PREPARING A STUDY ON LONG-TERM MINING AT OPEN PIT MINE UGLJEVIK EAST1

In this paper, the methodology for the preparation of a Study on Long-Term Mining is presented on the example of the M&TPP Ugljevik, i.e. Open pit mine "Bogutovo village East 1", and the basic functions and needs of the preparation of such a document can be stated as follows:

- Definition of a long-term coal mining plan with projected annual quantities until the end of the life of the basin mining and adoption of a long-term concept of

coal mining development thus harmonizing the dynamic development of mining works while defining the priorities of subsequent activities;
- Capturing mining all available coal reserves in the deposit as a function of the operation of the existing thermal capacity;
- Definition of techno-economic conditions and, accordingly, forecasting of the necessary investment activities, which will ensure the required level of production of the M&TPP Ugljevik system;
- Creation of conditions and final underlying instruments for the accelerated development of contracted mining projects in the remaining mining life, as well as procedures for the procurement of equipment, purchase of land, etc.;
- Defining the long-term strategy of the Mine and, as part of that, measures and programs to ensure stable and economically justified coal production in the long term period [1].

DEFINING THE GOALS OF THE STUDY, SOURCES OF INFORMATION AND BACKGROUND

The importance of coal, as a strategic energy raw material, but also as a great potential for the socio-economic and economic development of the Republic of Srpska. The Ugljevic coal basin currently represents the most important resource potential for the functioning of the Power Utility of the Republic of Srpska, and coal from this basin will undoubtedly be the primary raw material for electricity production for a long period of this century. As part of the Mixed Holding, Power Utility of the Republic of Srpska - Parent Company Joint Stock Company Trebinje, the Subsidiary Enterprise "Mine and Thermal Power Plant Ugljevik" Joint Stock Company Ugljevik operates, with address 76330 Ugljevik no number, Ugljevik (Internet address: www.riteugljvik.com). The main activity of the company is production thermal power energy and mining and sale of coal.

Objectives of the Study **-** The coal basin, which, according to the concession, is owned by Joint Stock Company Power Utility of the Republic of Srpska M&TPP Ugljevik includes two deposits: Bogutovo village and Ugljevik East 1, Figure 2. The boundaries of these areas are only of a technical nature in the geological and geographical terms, and have stemmed from the need for appropriately scheduled mining by technological units-areas, where the areas are geologically explored and defined differently. Mining works have been completed at the open pit mine Bogutovo village and are moving to the open pit mine Ugljevik East 1. By reviewing the existing design and technical documentation and analyzing the current state of the mining works and the remaining reserves, certain goals and purposes of the Study were defined:

- Definition of techno-economic conditions and prediction of necessary investment activity, which will ensure the required level of production, and thus the long-term safety of thermal power plant "Ugljevik" with an installed capacity of 300 MW and the electric power system of the Republic of Srpska,
- Definition of a long-term coal mining plan (annual amount until the end of the basin's mining life, with the capture of all available coal reserves in the deposit as a function of the operation of the existing thermal capacity),

- Adoption of a long-term concept of coal mining based on conceptual project solutions from the valid mining project documentation and analysis of the achieved work results, taking into account the available data on the degree of performed exploration and on the balance reserves from the valid
- Harmonizing the dynamic development of mining works and defining the priorities of subsequent activities. This will create the conditions and provide the final underlying instruments for accelerated construction of contract mining projects [1].

The planning of the mining system relies to a significant extent on the existing mining project solutions as well as the valid final geological Survey (with the state of works at the end of 2015 and approved in 2017). One of the starting points is the currently available mining machinery and surface mining technology. A special problem is represented by the bordering parts of the Bogutovo village deposit with the Ugljevik East 1 deposit, where it is necessary, on the basis of all boreholes and geological works, to "reinterpret" the time-schedule of coal mining, taking care to meet the basic requirements related to the quantity and quality of coal needed for the operation of the thermal power plant.

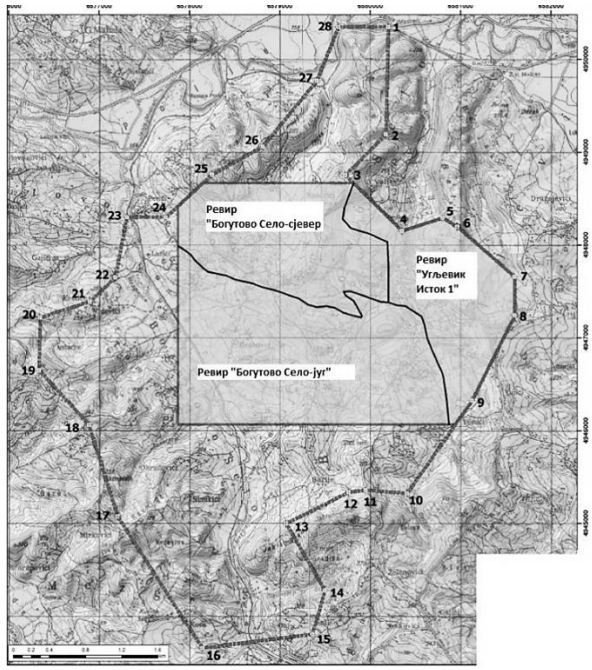

Figure 2, Topographical map showing the mining field "Bogutovo village i Ugljevik East 1" near Ugljevik, 1:25,000

Sources of information **-** The developers had the basis and sources of information necessary for the analysis and preparation of this Study in the geodetic and geological underlying instruments and operational and project mining documentation that the Investor has and which was available during the preparation of the Study.

ANALYSIS OF THE CURRENT STATE OF WORKS,
EQUIPMENT, FACILITIES AND THE ENVIRONMENT

Description of previous mining works and current situation **-** Coal mining within the Ugljevik coal basin dates back to the beginning of the 20th century. With the opening of the open pit mine "Bogutovo village " and the construction of the thermal power plant "Ugljevik" with an installed capacity of 300 MW, the Ugljevik basin is a significant energy potential of both the Republic of Srpska and Bosnia and Herzegovina. Coal mining within the existing surface mine "Bogutovo village " ended at the end of 2022, and it was necessary to carry out all the planned activities for the opening of the replacement capacity, which is the surface mine "Ugljevik East 1". The eastern slope of the "Northern area - Eastern mining field" was the final stage of mining and in that zone the area of the surface mine Ugljevik East 1 is entered. The Ugljevik River had to be relocated again. A significant purchase of buildings and land belonging to the excavation field "Ugljevik East 1" was carried out, whereby the entire settlement of Old Ugljevik was evicted and demolished, although significant areas remained for further purchase. In terms of engineering and geological conditions, there are significant deformations towards the east, Figure 3.

Presentation of the mining system - the same mining system was designed for the surface mine "Ugljevik East 1" as at the Open pit mine Bogutovo village. The system of surface mining at Open pit mine Bogutovo village and later at Open pit mine Ugljevik East 1 consists of two basic production processes:

- Production process on overburden with technological operations: excavation, loading, transport and disposal (discontinuous system on excavation and transport of overburden - hydraulic shovel excavators - trucks)
- Coal production process: mining, loading, transport, preparation and shipment (combined system in coal mining, where hydraulic shovel excavators are used to mine coal, and trucks are used to transport coal to the primary crushing plant and belt conveyors to the secondary crushing plant and further towards the thermal power plant) [5].

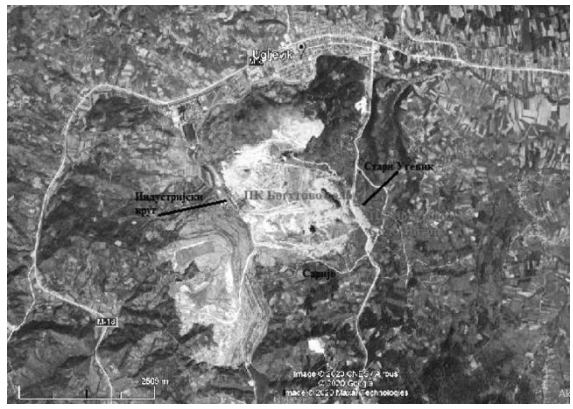

Figure 3, Geographical presentation of mining facilities M&TPP Ugljevik (GoogleEarth, May 2020)

Analysis of available equipment - For the purpose of a more detailed and accurate overview of the availability of excavators, trucks, dozers, loaders and other equipment that has been used so far and with the aim of better long-term mining planning, data on physical availability and utilization of availability for all equipment in the past five-year period were analyzed and statistically processed in addition to the realization of the capacity of each individual machine.

When defining the plan for the use and write-off of existing/available machines, an overview of the achieved and planned amortization periods of equipment for loading (excavators on overburden and coal), transport (trucks on overburden and coal) and auxiliary technological operations - dozers, graders and other auxiliary machines was made. The review gave the achieved average annual effective hours of operation of individual machines, the total number of motor hours that the machines need to realize before their write-off, as well as the average number of years of use. Based on this, an overview of the use plan and periods of use of certain types of machines at the Ugljevik Mine was defined, which represents the plan of use and write-off of existing/available machines. This was the starting point for defining the dynamics of procurement of new equipment in the future period of exploitation [1].

Presentation of the current state of the drainage system and definition of the basic concept of further defense of surface mines from surface and underground water **-** the current concept of drainage and hydrotechnical facilities (peripheral channels, sedimentation tanks, water collectors, drainage channels, pumping stations, pumps and pipelines, the needs of relocation of the Ugljevička River) were reviewed. ...). Based on that, the future needs of drainage, the organization of drainage, the necessary equipment and the dynamics of its procurement were analyzed.

DEPOSIT MODELING WITH RESOURCE ESTIMATION

The coal deposit was digitally represented by geological modeling based on the collected geological and geophysical exploration data (numerical equivalent of a three-dimensional geological map) [6]. Geomodeling included a preliminary analysis of the geological concept in the field of explorations, the creation of a base of exploration works and validation, the interpretation of available data and observations, both at the point and at the level of polygons and lines in space, the creation of a lithostratigraphic-structural model that describes the relationship of geological units, the definition of a three-dimensional network that follows the litho-structural model and supports volumetric representation, creation of 3D block models based on a three-dimensional network, and assignment of variables, and assessment of the content of useful mineral components, and other variables (volumetric mass, fracture, groundwater level, etc.) using geostatistics within the block model.

The Bogutovo village and Ugljevik East 1 coal deposit model for the purpose of assessing the potential of Bogutovo village and Ugljevik 1 was created using the GEOVIA Surpac v.6.8 TM software package. A 3D geometric model of the main coal (MCS), first (I) and second (II) coal seams was generated.

Validation of the block model was done statistically through the trend analysis of the estimated blocks and composites by X, Y and Z coordinates, as well as by visually comparing the original geological profiles and the block model.

Resource assessment - Bogutovo village and Ugljevik East 1 resource assessment was done with a lower selectivity limit of 0.7 m and 54.23x106 tons were obtained with an average DTEcontent of 11558 kJ/kg, of which the "A" category of measured resources is 5.46x106 tons with an average DTE content of 12348 kJ/kg, "B" measured resources is 24.94x106 tons with an average DTE content of 11135 kJ/kg, "C1" category indicated is 9.9x106 tons with an average DTE content of 12438 kJ/kg, and "C2" off-balance is 13.95x106 tons with an average content of DTE of 11380 kJ/kg [1].

STRATEGIC PLANNING AND DESIGN OF OPEN PIT MINE

Assessment of mineral reserves **-** In order to determine as accurately as possible the mining and economic potential of the coal deposit "Ugljevik-East I", a comprehensive analysis was undertaken, which included the contouring of the basic mining facilities, i.e. mines and landfills. Accordingly, pursuant to the Terms of reference of the Study, the following was carried out:

- Optimization of the mine limits, which defines the *mining reserves* necessary for the stable supply of the existing thermal power capacities,
- External and internal landfills were constructed, which ensured space for disposal and verified efficient feasibility of technological excavation operations and disposal of tailings, respectively.
- The necessary capacities for tailings and coal during the mining life are defined. Coal capacities are defined in accordance with the Investor's requirements for coal quantities of 1,750,000 t/year, and tailings capacities are defined based on the need to ensure continuity in the supply of coal and during most of the mining life they amount to 11.5x106 cm3 of tailings.
- In accordance with the defined capacities, the dynamic conditions of the development of the surface mine and landfill were constructed.
- The basic infrastructure on the mine was defined, which established communications for the flow of materials, equipment and personnel on the mine. This was largely done by taking into account the current infrastructural situation at the mine as well as on the basis of the existing and valid project documentation.

Mine design optimization Bogutovo village 1 – By surface mine optimization procedure Using Whittle Four-X TM optimization algorithms (LG 3D) and the Milawa Balance optimization algorithm, a series of surface mine shells was determined based on different income factors with an iterative step of 0.025 coal price change in compared to the base price of €2.2/GJ. The optimal mine is the one with the limit that generates the highest cash flows (discounted or undiscounted) using previously defined input parameters. The maximum profit in this analysis is realized for the construction of the pit shown in Figure 5.

Geomechanical verification of the slope stability of the surface mine **-** taking into account the physical and mechanical characteristics of the rock massif and the lithological

members in it,respectively, an analysis of the stability of the slope at the surface mine "Ugljevik East 1" was performed on 5 characteristic profiles.

PLANNING OF PRODUCTION AND DYNAMICS OF MINING AT OPENPIT MINE

Development of mining works **-** In the forthcoming period, the development of mining works can be characterized as relatively complicated. The reasons for this are primarily related to the nature of the equipment, i.e. the deposition of coal layers and the fact respectively, that one deposit (Bogutovo village) is being transferred to a practically new deposit (Ugljevik East 1), where it is necessary to maintain continuity in production and projected capacities. Designing the development of mining works was done in accordance with the following goals:

- Provision of projected quantities of coal in the amount of 1.75x106 t per year,
- Creation of conditions for the successful relocation of the Ugljevik River and the road in the area of the Ugljevik East 1 deposit,
- Creation of conditions for the formation of an internal landfill, in order to reduce costs so that exploitation parameters are more efficient.

Such strict goals and restrictions narrowed down the number of possible solutions and to a large extent predetermined the possible development of the mine works. The minimum mining coefficient of the overburden was defined, necessary in order to maintain the continuity of excavating the projected annual quantities of coal. The results of this analysis showed that during most of the future mining, it is necessary to excavate 11.5x106 cm^3 of tailings, in order to ensure continuity at the projected coal capacity of 1.75x106 t.

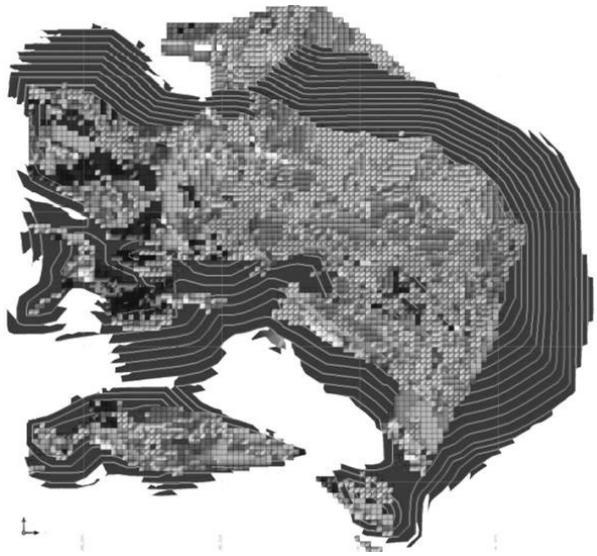

Figure 5, Constructed final surface mine contour and coal in the deposit - top view

SELECTION AND PLANNING OF ACTIVITIES AND EQUIPMENT WITH OPTIMIZATION OF THE MINING SYSTEM

Dimensioning of the mining system and selection of equipment **-** Dimensioning of the loading and transport system was done on the basis of certain restrictions on the surface mine itself, available equipment, estimation of effective working hours and requirements of the Terms of reference:

- Projected coal and overburden capacities;
- Organization of work on surface mine; and
- Existing technology, available equipment and rate of its use (depreciation) and estimated effective operating time of available equipment.

When sizing the equipment for loading, transport, and auxiliary technological phases, the organization of mine work and basic parameters were adopted based on the principle of downloading real data from, until now, the active mine [7]. The organization of work at the surface mine is based on work in three shifts throughout the year. The total number of shifts that can be achieved annually with this organization is 1,095. However, taking into account bad weather conditions, 79 rainy days were taken into account, which basically means that the final number of shifts during the year is 858.

Then, the age structure and write-off plan of individual machines were analyzed comparatively, on the one hand, and the re-dimensioned systems of loading and transport equipment, auxiliary and other necessary equipment for the functioning of the mine.

Dimensioning of the mining system and mining technology/equipment was carried out by creating a simulation model for each individual system as well as for each position of the system (in relation to the loading and unloading point) within the projected capacity and the estimated pool of effective working hours for a particular year of operation. Using the programme Haulsim1 (RungePincockMinarco Limited), loading transport systems were modelled by forming transport routes for overburden and coal by individual years, associated with specific loading transport systems, defined organization and pool of available effective working time. Individual centres of mass of excavated mass (overburden or coal) have been determined for all active sites by individual years of operation. On the basis of specific centres of mass and a known place of unloading, average transport routes were formed.

Dimensioning of the mine protection system against surface and underground water was done on the basis of project solutions for the protection of the mine against water with an account of the equipment in the first five years, dewatering after five years of operation and dewatering at the end of the mining life. In addition, the capital investment plan is presented.

Dimensioning of the necessary auxiliary machinery and equipment - in the same way as in the case of basic operations, all the necessary auxiliary works on the surface mine are shown and described in the first five years, after ten years and at the end of mining, and on the basis of the same, the number of required auxiliary machinery machines for each type of auxiliary technological operations is determined.

ENVIRONMENTAL IMPACT ANALYSIS AND RECLAMATION

Reclamation **-** Reclamation measures or works include mining and technical activities, engineering works, land reclamation activities, forestry works and agricultural works [8]. For the recultivation of the subject "Ugljevik East 1" and "Bogutovo village ", recultivation with the following stages will be applied:

- Technical recultivation, which includes: improvement of access roads to landfills and tailings ponds, as well as levelling of final surfaces - plateaus of landfills and tailings ponds, anti-erosion works - cutting of terrace planes on terraced slopes of landfills and dams of tailings ponds
- Agrotechnical recultivation includes measures: calcification, fertilizing, plowing, disc harrowing, dragging, pre-sowing preparation, sowing, mechanical digging of pits for seedlings;
- Biological recultivation, which includes a complex of biotechnical and phytomelioration measures with the aim of greening surfaces on previously prepared surfaces.

The needs for recultivation works, the dynamics of carrying out certain works of this type, and the assessment of financial resources and the dynamics of providing them are defined.

*Analysis of environmental impac*t - included the definition of environmental protection and rehabilitation measures with the identification and assessment of the impact of mining operations and facilities, treatment of dust, exhaust gases, waste water, solid waste, air and noise protection management, and the already mentioned recultivation works. Environmental impact of mining operations with impacts on the rate of population, social structure and population concentration and migration, as well as potential impacts on local traffic, electric power, hydrotechnical infrastructure and heating were also pointed out. As part of this group of jobs, the categorization and modification of the land structure was given as a necessity for the relocation of residential buildings and infrastructure facilities.

ECONOMIC AND FINANCIAL ANALYSIS AND EVALUATION OF THE PROJECT

Assessment of capital and operating costs **-** The goal of the assessment of capital and operating costs of the project is to estimate the expected total costs of the project with sufficient accuracy, which would allow the owner to make appropriate decisions about the value of the project and the possible risks of its implementation through economic evaluation. The costs are calculated and given in generally accepted units of KM/t of excavation. Two types of costs were considered:

- Capital expenses (CAPEX) - refer to the acquisition and ownership of mining equipment as the property of the mine and consists of the following items: depreciation, interest, insurance and tax.
- Operating costs (OPEX) - include the costs of standard materials, electricity, equipment maintenance, employee costs, etc. These costs are proportional to the projected annual coal mining capacity and are calculated on an annual basis.

Economic and financial analysis - The most important criterion for making a decision on investment and realization of an energy project is the financial profitability of the project, which means that the financial return (profit) is sufficiently high and fast. Therefore, the economic-financial assessment of the project should be performed and presented so that the project investor has enough reliable information to estimate the return on investment, taking into account the expected financial risks of the project [8]. The economic evaluation of mining projects is usually based on the discounted cash flow (DCF) methodology. It is projected in such a way that all cash inflows and outflows during the life of the project are calculated. The model takes into account the time dimension of money by discounting it with an appropriate discount rate to obtain the present value and other DCF parameters, such as gross profit, defined as revenue minus production costs, earnings before deduction of interest, depreciation and amortization, earnings before deduction of interest and taxes, net present value, internal rate of return and payback period (PP).

The production and technical data projected in the technical part of the Study were used for the design of the economic model in order to determine the economic parameters of the project. The financial analysis is primarily based on the planned production capacity of the mine, investment and operating costs, and the estimated selling price of coal. Therefore, all assumptions related to cost prices and other parameters in the study (e.g. risk factors that have been identified, etc.) can have a significant impact on the accuracy of the economic analysis. For these reasons, capital investments, project financing and annuity calculations, as well as capital and operating costs (fixed and variable) are defined in advance. A sensitivity analysis of these parameters was also performed in order to create prerequisites for making valid business decisions.

Economic and financial assessment of the project - includes income assessment, static and dynamic assessment of the project with an analysis of the project's sensitivity.

Income assessment - the assessment of operating income was made based on the fact that the final product of the company M&TPP Ugljevik is a commodity (electricity) and that the income of the mine largely depends on the price of coal according to the thermal power plant. Thus, the economic analysis provides a framework in which the entire project should be viewed with price limits that will affect the economic performance of the project. No electricity price forecast was made, and the coal price used in the Study resulted from data from previous production, existing documentation, necessary investments, financing methods and other exogenous economic parameters that determine the level and structure of production costs at the Ugljevik East 1 surface mine.

Static analysis and assessment of the project - based on individual indicators derived from cash flow data such as income statement, balance sheet and financial cash flow for the so-called. a "representative" year of mining at full capacity utilization. The results of the income statement show that the "Ugljevik East 1" project will operate with a significant profit, amounting to 185.6 million KM, in the considered life of the project of 16 years. The price of coal production ranges from 37 to 45 KM/t, while the average over the life of the project is 39 KM/t.

Dynamic project analysis **-** assessment of mining investment projects in practice is most often done using two discount techniques when it comes to assessing financial profitability, namely: the net present value method and the internal rate of return method. The financial flow of cash provides all the values needed for the calculation of NPV and IRR, which are used to evaluate the project from the investor's point of view.

For the dynamic evaluation in this case, the relevant discount rate is 8% and the investment payback period. The internal rate of economic effectiveness (IRR) was obtained at the level of 9.21%, and the payback period (PP) was 3.2 years. The net present value (NPV) of the project, determined as the discounted sum of the net income of the economic flow for the covered period of 16 years, with a defined marginal discount rate, amounts to 38.6 million KM

Project sensitivity analysis **-** is used to assess the stability of the obtained project profitability indicators under different levels of sensitivity to key project parameters. For this project, three key parameters were adopted for the sensitivity analysis of the projected economic effects, namely the selling price of coal, investments and costs of normative materials.

Three key variables are varied separately and estimate possible real changes in the amount of total revenues from the sale of coal or electricity. Changes of these parameters were made in the range of +20% to -20% with a step of 5 percentage points. It has been shown that the selling price of coal has the greatest influence, so that with its reduction by 20%, the IRR rate drops to -8%, and with an increase by 20%, the IRR rate increases to 32%. These price changes show that the project is at the break-even point if the price of coal falls below 10%. The second parameter in terms of importance and influence on the projected IRR rate is operating costs, so an increase in these costs by 20% brings down the IRR to the level of -2.4%, and reducing costs by 20% raises the IRR to 24.4%. This analysis showed that the least impact has the volume of investments, which gives high references to this project, from the aspect of securing the necessary capital. However, it is not realistic to expect a significant reduction in investments, but an increase in investments by 20% (which is a more realistic estimate) reduces the IRR rate to 7.61%.

CONCLUSION AND RECOMMENDATIONS

The results of certain techno-economic analyses and evaluations of certain mining projects have a "limited time of use", i.e. the actuality itself. The use of certain discount rates that take into account the time factor from the aspect of the specific characteristics of the mine location in terms of economic development, credit rating, economic growth, political and social risks of a certain country/state sometimes depends a lot on geopolitical conditions in the world and less on concrete conditions on the ground. Thus, a mine can have a much higher value in one location compared to another, so although this can be considered somewhat logical in terms of the techno-economic effects of its use, it imposes the need for more frequent "review" of the working conditions and prospects of individual mines.

The structuring of important parameters that determine the basic techno-economic effects of the work of certain methods and exploitation systems, on the basis of which the future working conditions of a mine can be defined, i.e. specific moments of the working conditions at which the costs of the surface mining work remain economically profitable according to certain changes in production capacities, technology and exploitation systems. The conceptual setting of all the necessary analyses and necessary decisions that need to be made throughout the life of mining with monitoring of the system's operation in real time with an assessment of its efficiency can be adjusted over time, i.e. expanded or narrowed depending on the size, complexity, but also the attractiveness and importance of the mineral raw material, and the periods between studies and analyses are shortened or extended according to the needs of the mining companies themselves on the one hand, and the countries where the mine is located, on the other hand.

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