

Opening, development and exploitation of coal deposit Mariovo in Republic of Macedonia with underground mining technology

Odpiranje, razvoj in izkoriščanje premoga v nahajališču lignita Mariovo – Makedonija z jamsko tehnologijo

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Abstract

Coal deposit Mariovo in Republic of Macedonia is one of many unused natural resources in Macedonia. The reason for unexploited energetic potential is relatively large distance from energetic locations, where the coal could be used for production of electric energy. Investor – ELEM (Macedonian Power Plants), Macedonian state owned company, that unites all major power producers in the country, wants to open the mine by the year 2017. Premogovnik Velenje participated in research of coal deposit with a team of design engineers, who directed the research works. The team of design engineers also completed all the design documentation from opening of the deposit till the full capacity of underground production which would be 2 million tons per year.

Key words: coal mine, coal deposit opening, underground mining technology, process of opening the deposit

Izvleček

Nahajališče lignita Mariovo v Republiki Makedoniji velja za enega od mnogih neizkoriščenih naravnih rudnih bogastev Makedonije. Razlog za neizkoriščenost tega energijskega potenciala je relativno velika oddaljenost od energetskih lokacij, kjer bi lahko premog pretvorili v električno energijo. Investitor – ELEM (Elektrani na Makedonija), makedonsko državno podjetje, ki združuje vse večje proizvajalce električne energije v državi, želi rudnik odpreti do leta 2017. Premogovnik Velenje je sodeloval pri raziskavah nahajališča z ekipo projektantov, ki je usmerjala raziskave, in izdelal glavni rudarski projekt za odpiranje in razvoj nahajališča premoga, ki obsega vso projektno dokumentacijo od odpiranja do polne kapacitete premogovnika, ki je 2 mio. ton na leto.

Ključne besede: premogovnik, odpiranje nahajališča, jamska tehnologija, postopek odpiranja nahajališča

Introduction

Coal deposit Mariovo in Republic of Macedonia is one of many unexploited natural resources in Macedonia. The relatively large distance from energetic locations, where the coal could be used for production of electric energy is the reason why this deposit is still intact. Nonetheless, the extensive geological and hydrogeological research has been done. The complete deposit has been bored through with the last research series completed in 2010. Results of all the research work enable to start the work on mine design. Members of the design team of technical services of Velenje Colliery participated as consultants in the research work.

Scope of work

Investor – ELEM (Macedonian Power Plants) and Premogovnik Velenje (Velenje Colliery) signed a contract for elaboration of mining project containing all the necessary documentation – starting with research and ending with first tons of coal on the stockpile. The following studies and projects^[1] were finished:

- technical – economical part of the report on classification in categorization of coal reserves,
- basic concept for exploitation of lignite in the Mariovo deposit,
- the main mining project that contains:
 - technical project for opening and development of the deposit,
 - technical project for mining technology (mining method),
 - technical project for ventilation,
 - technical project for dewatering,
 - technical project for underground coal haulage,
 - technical project for surface transport system;
- project for elaboration of industrial circle with infrastructure,
- project for supply of the mine with electric energy,

- project for lignite crusher system,
- project for automatic remote control of ventilation, fire protection and technological parameters of the Mariovo mine,
- project for supply of the mine with compressed air,
- project for supply of the mine with technological and drinking water,
- project for supply of the mine with fly-ash mixtures for isolating lining,
- project for supply of the mine with hydraulic emulsion,
- project for environmental impact of Mariovo mine and surface structures,
- project for fire protection of surface structures,
- project for organization of the work at coal production and service activities,
- project for disposal of tailings (mine dump),
- time plan for activities at mine construction until the planned production capacity is reached.

In addition we provided the investor all the necessary documentation demanded by EBRD (European bank for reconstruction and development) considering environmental impact of the mine and supporting facilities including Environmental impact report.

Project review has been done by Faculty of Natural Sciences and Engineering Ljubljana, and the project basics have been presented to the Macedonian expert public at symposium in Negotino town in July 2011.

During projects elaboration the need for quite many additional activities arose and for these we include the home companies from Šalek valley and surrounding regions. This is not coincidence as the knowledge on all aspects of mine design and construction is concentrated right in Šalek valley. The project partners were: Erico, d. o. o., Econo, d. o. o., PPS Prizma, d. o. o., Kova, d. o. o., Salus, d. o. o., Possi, d. o. o., and numerous individual experts covering various fields (miners, engineers, electricians, energy experts, environmentalists, civil engineers, biologists, geographers, geologists, chemists and experts for safety at work).

Mariovo deposit

Mariovo lignite deposit (Figure 1) extends over the area of $8 \text{ km} \times 2 \text{ km}$ at the depth of 100–200 m under the surface. The region is uninhabited and there is hardly anything to be found there except the onyx quarry and a 400 kV power line connecting power plant TE Bitola and power plant TE Negotino. The average calorific value of the coal is relatively low reaching 8 MJ/kg, being otherwise characteristic for also other coal deposits in this region (Bitola, Pelagonia basin). The seam is in average 7 m thick, reaching maximum thickness of 16 m. The floor strata consist mainly of clays and sands but in the roof mostly mudstones and marls prevail. The coaly substance with calorific value above 6.5 MJ/kg is considered reserves and amounts up to 96 Mt, of which some 61 Mt can be won by mining. Considering the mine capacity of 2 Mt per year the operating time of the colliery is round 30 years.

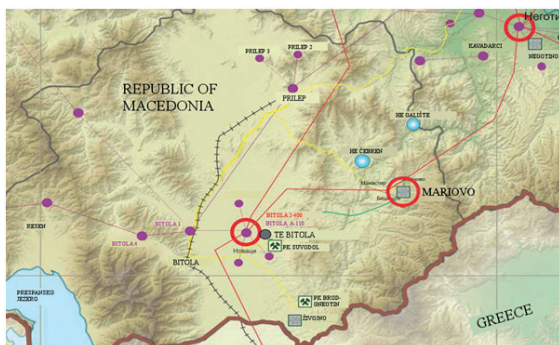


Figure 1: Coal deposit Mariovo, Živojno and Negotino position according to location of Macedonian republic's energy producing localities (thermal power plant TE Bitola, thermal power plant TE Negotino, hydro power plant HE Čebren and hydro power plant HE Galište).

The deposit opening and excavation concept

The layout of excavation panels enables a maximal seam recovery. General panel orientation is south – north. The panels are approximately 180 m wide and from 310 m to 1400 m long (Figure 2). At the delivery side of the excavation panels (eastern side) the blind end parts of longwall faces in length of approximately 20 m are positioned (in such way the mining losses are reduced).

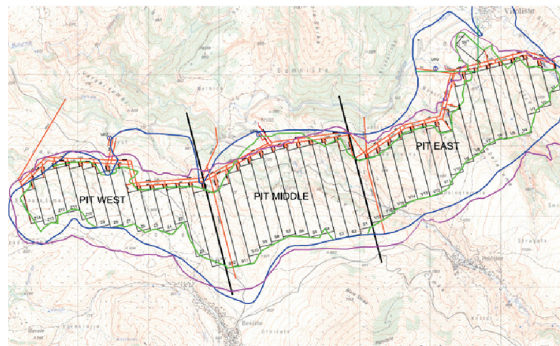


Figure 2: The Mariovo mine opening and excavation concept.

The basic technical conditions for mine opening and coal excavation with expected production results:

- coal production will reach approximately 2 Mt per year,
- two excavation panels working at the same time, two in developing phase,
- three sets of excavation equipment available,
- panel development will run at six worksites,
- worksite daily advance at elaboration of permanent (access) roadways will reach in average 2 m/d,
- worksite daily advance at elaboration of gate roads will reach in average 4.5 m/d,
- in average we plan 21 working days per month and 3 shifts per day,
- average production of one excavation panel will reach round 4000 t/d.

Mariovo mine is divided into three pits: eastern pit, middle pit and western pit. Production will start in the eastern pit and continue towards west. Ventilation is adapted to this sequence.

According to research results the Mariovo mine is a gassy one and therefore all the equipment must suit the appropriate requirements for intrinsic safety. Total installed power supply for electric machinery equipment in Mariovo mine amounts 16.5 MW.

Mine operation will require elaboration of:

- 25 770 m of permanent (access) roadways (main gates, ventilation roadways, tailgates, dewatering roadways) of cross section area from 12 m^2 to 14 m^2 ,
- 95 700 m of panel roadways (haulage (belt) roads, delivery (travel) roads, face roads) of cross section area 17 m^2 .

Excavation technology in the areas where seam thickness is round 4 m enables to excavate only

the lower part of the panel but in the areas where the seam is thicker the excavation is divided into lower part where the coal is cut by the shearer and the upper part where the coal is won by making it fall down in pieces.

At longwall face that is 180 m wide there are 120 longwall shields (chocks) installed (unit width is 1.5 m). These shields enable to control how the crushed coal from the upper section is falling down (coal flow). The coal is cut with two drum shearer. Face conveyor for coal haulage consists of two chains and its capacity is 530 t/h.

Hydrogeological conditions of the deposit dictate a complex and comprehensive dewatering process.

Dewatering of the mine is foreseen to be done completely from underground structures:

- the roof aquifers: preliminary dewatering of the roof aquifers (especially aquifer K2) will start with construction of the dewatering roadway that is located directly in the aquifer and continue with drilling of dewatering boreholes from this roadway,
- at worksites: the water will flow into convenient water tanks located at the worksites from where it will be pumped into the channels. From the predominant part of the mine the water will flow gravitationally.

In total it is going to be necessary to drill from 40 000 m to 50 000 m of dewatering boreholes.

Time schedule

The most important information from time plan is the following:

- start of preparation works is foreseen in July 2013,
- first production in 2016–2017 (1.5 Mt),
- full production (2 Mt per year) is reachable in 2018,
- in the first year of mine operation it will be necessary to employ 177 workers, for the second and the third year yet additional 100 workers, in the fourth year there will be 522 workers needed. In this the 20 % of fluctuation must be considered.

Economic evaluation of the project

Elaboration of the economic evaluation of the project is based on the following premises:

- exploitation reserves: 61 260 000 t,
- average calorific value of exploitation reserves: 8.3 GJ/t,
- mine production round 2 Mt per year,
- investments taken into consideration until production start,
- material and services costs taken into consideration,
- ongoing investments during production taken into consideration,
- labor cost (gross gross): = 700 EUR/worker/month, 500 employees,
- financing costs taken into consideration,
- two simultaneously running longwall faces,
- two panels in the preparation phase,
- three sets of excavation equipment available,
- panel development will run at six worksites,
- two ventilation stations,
- one crusher station,
- in average 21 working days per month and 3 shifts per day,
- no time wasted between one panel excavation finish and next panel excavation start (this is possible because of the third set of the excavation equipment),
- average production of one excavation panel will reach round 4000 t/d,
- for dewatering of aquifers drilling of dewatering boreholes is foreseen,
- from the predominant part of the mine the water will flow gravitationally,
- elaboration of three dewatering roadways in the roof aquifer,
- from 40 000 m to 50 000 m of dewatering boreholes,
- surface coal transport not taken into consideration,
- unexpected expenses that might occur because of local conditions not taken into consideration,
- constant prices from May 2011 taken into account.

Results of the technical - economic evaluation:

- the version with 30 % own funds and 70 % debt sources structure,
 - internal rate of return: 5.94 %,
 - payback period: 18 years,
 - total cost of operation from 2013 to 2045 as the mine is closed: 781 million EUR,
 - total revenue is 980 million EUR.

The project is positive, appropriate funding is needed to finance the project until 2018 when complete production starts and begins to pay the money back.

Conclusion

Depending on the chosen financing model the complete investment value is round 110–121 million EUR. Two different financing models have been treated with on one side larger and on the other side smaller investors' share. The model using 30 % of the own funds shows the investment to be returned in 18 years. Economic calculation can confirm the statement on exploitation of own natural en-

ergy sources in combination with appropriate excavation methods to be most rational. Such approach is certainly placed in front of cheap coal import as the socioeconomic effects are in case of mine construction not insignificant. As foreseen, the excavation will go on at two simultaneously running longwall faces. Six work-sites will meet the needs of panel development and elaboration of permanent roadways. Considering Premogovnik Velenje Company, elaboration of design documentation represents additional income, a good reference and a good opportunity for Slovenian companies to collaborate in potential opening operations and introduction of Velenje mining method in Republic of Macedonia.^[1]

References

- [1] Premogovnik Velenje – Technical services (2012): Main mining design for opening, preparation and coal exploitation with underground mining technology in the Mariovo coal mine, Macedonia; Slovenia 2012, Books 1–16.

