

Situation analysis and assessment of investment starting points for opening and exploitation of Brnica Mine

Analiza stanja in ocena investicijskih izhodišč za odpiranje del in pridobivanje premoga v rudniku Brnica

Evgen Dervarič^{1,*}, Aleš Berger², Franc Blaznek³, Željko Vukelič¹

¹University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Mining and Geotechnology, Aškerčeva 12, 1000 Ljubljana, Slovenia

²RTH, d. o. o., Trg revolucije 12, 1420 Trbovlje, Slovenia

³TET, d. o. o., Ob železnici 27, 1420 Trbovlje, Slovenia

*Corresponding author. E-mail: evgen.dervaric@ntf.uni-lj.si

Abstract

The Faculty of Natural Sciences and Engineering in Ljubljana has conducted extensive research for assessment of reserves as well as technical and economic factors influencing the feasibility of opening a part of unexploited seam in the former Hrastnik mine between the height points +50 and -60 in the central section of the mine; the seam was named Brnica. Coal reserves in the Brnica area amount to at least 6.25 Mt (according to estimates, at least 2.5 Mt to 4 Mt of coal could be released from the mine after additional exploration), and it would be reasonable to extract them to supply the Trbovlje Thermal Power Plant (TET) which is about to remain without the cost-competitive domestic energy feedstock already in mid-2013.

The planned quantity of coal production would amount to 310 000 t per year in the period from 2014 to 2033, the total excavation amount would be 6.25 Mt of coal with average heating value of 12.10 GJ/t. The planned selling price of coal would remain constant throughout the entire period of operation of the mine, i.e. 2.60 EUR/GJ.

The economic valuation of the project was conducted by using three methods for valuation of investment projects: the net present value (NPV), internal rate of return (IRR) and the payback time method (PBT).

The present article presents the fundamental conditions for the opening and exploitation of the Brnica brown coal mine.

Key words: energy industry, coal reserves, heating value of coal, investment project economics, opening of a coal mine

Izvleček

Naravoslovnotehniška fakulteta iz Ljubljane je izdelala obsežne raziskave za oceno zalog in tehnično-ekonomskih vplivnih dejavnikov izvedljivosti odpiranja dela še neizkoriščenega sloja bivše jame Hrastnik med kotama +50 in -60 v centralnem delu jame; sloj je dobil ime Brnica. Zaloge premoga, ki se nahajajo v območju Brnice, so najmanj 6,25 Mt (ocena je, da bi se po raziskavah iz jame sprostil vsaj še 2,5 Mt do 4 Mt premoga), zato ga je smiselno kopati za potrebe Termoelektrarne Trbovlje (TET), ki je že sredi leta 2013 ostala brez cenovno konkurenčnega domačega energenta.

Načrtovana količina izkopa premoga bi bila v obdobju od 2013 do 2034 310 000 t, skupaj bi se izkopalo 6,25 Mt premoga povprečne kurilne vrednosti 12,10 GJ/t. Načrtovana prodajna cena premoga bi bila v celotnem obdobju delovanja rudnika konstantna, in sicer 2,60 EUR/GJ.

Ekonomičnost projekta smo ugotavljali s tremi metodami vrednotenja investicijskih projektov, in sicer z neto sedanjno vrednostjo (NPV), interno stopnjo donosnosti (IRR) in metodo dobe vračila (PBT).

V tem članku so predstavljeni temeljni pogoji za odpiranje del in proces odkopavanja v rudniku rjavega premoga Brnica.

Ključne besede: energetika, zaloge premoga, kurilna vrednost premoga, ekonomika investicijskega projekta, odpiranje rudnika

Introduction

By adopting the Act Regulating *Gradual Closure of the Trbovlje-Hrastnik Mine (hereinafter: RTH^[1]*, the Republic of Slovenia has made a decision to close coal mines in the Zasavje region until and including the year 2015. RTH *supplies coal exclusively to the Trbovlje Thermal Power Plant (hereinafter: TET)*. The operational life of TET is gradually being extended by eliminating the restrictions by means of technological modernisations prescribed in the laws and regulations of the EU and related to emissions into the atmosphere. TET is planning to produce electricity with the existing installations until 2017, when more stringent requirements of environmental protection will come into force. TET is an important energy location for Slovenia^[2], a decision on its comprehensive modernisation has not been made yet. Such decision could be largely and or even crucially related to the possibility of further production of coal in the Zasavje region and its coal for the power plant at the price reasonable for the power plant.

In the second half of 2013, TET is about to remain without cost-competitive domestic coal from RTH. The price of coal from RTH is a little less than 3 EUR/GJ, and the current offers for imported coal in world markets exceed the price of 4 EUR/GJ. Further operation of TET and its supply of cost-competitive coals, which are crucial for the existence of TET, led us to study the possibilities of opening and excavation of the remaining coal reserves in the Zasavje region.

The potential excavation reserves of RTH (Expert report on reserves as at 31 December 2002) amount to 53 Mt of balance sheet reserves, including 24 Mt of excavation reserves at the average heating value of 11 MJ/kg.

The Brnica Mine

In the future, it will be necessary to change the attitudes towards domestic energy sources in electricity production and to thoroughly consider all the steps that will bring important decisions. The fundamental goal of Slovenian electricity sector is the maximum self-sufficien-

cy in power supply and exploitation of synergy effects by upgrading the balanced structure of energy sources in Slovenia (1/3 hydropower, 1/3 nuclear power, 1/3 thermal power). Long-term conservation of coal extraction in the Zasavje region^[3] is important for the diversification of energy sources, especially for electricity production. Being a domestic energy source, coal significantly reduces the risk of power supply failure. It would be reasonable to use the remaining coal reserves in the Zasavje region in relation to the investment in TET which is an important energy location for our country and will have to be preserved in the future. Continuation of coal mining in the Zasavje region and the planned opening of the Brnica Mine and operation of TET has strong support from local communities in the region. All investments in new energy facilities in both Slovenia and Europe are contributing to higher energy, environmental and economic efficiency.

The Brnica Mine represents the excavation potential of an unexploited section of the seam in the Hrastnik mine which operated under the company Rudnik Trbovlje-Hrastnik, d. o. o. It is evident from the study "Options for Coal Mining Operations in the Brnica Area"^[4] that coal reserves of sufficient quality amount to at least 6.25 Mt. According to estimates, coal reserves in the Brnica area could be even greater: at least 2.5 Mt to 4 Mt of coal could be released from the mine after additional exploration^[5]. The reserves can be excavated in a commercially acceptable manner under the following conditions:

- with the entry of one or several strategic partners in the company TET. In this way, it would be possible to provide investment funds for the reconstruction of the thermal power plant as well as exploration and opening works in the mine;
- the company Brnica Mine would be established as a limited liability company and would not have any relation with RTH;
- the sale of coal to TET or TEŠ is guaranteed^[3] for the next 20 years or more, at prices at least 25 % lower than the supply from competitive global coal suppliers;
- the company Rudnik Trbovlje-Hrastnik, d. o. o., is conducting the mine closure until 2015 (the costs of facility closure pursuant

to the RTH Act must be separated between RTH and, if necessary, the new company). The company RTH preliminary carries out all activities and obligations arising from "Permit for cessation of exploitation" No. 354-15-27/2003 and 354-15-6/2004, of 19 January 2005;

- the state, which is a 100 % owner of the property of RTH, assesses the facilities necessary for opening and excavation, and offers them for sale by public tender to the "new company", to which it also grants an excavation concession;
- the company RTH offers for sale to the "new company" its equipment that will no longer be needed after excavation;
- strategic investors make an investment in the "new company" in the form of construction of investment mine facilities, in the amount of approximately EUR 6 million. Capital works would be started in 2013, and then continued and finalised in 2014. In the year 2015, the first floor is prepared and then excavated by the end of the year;
- the new company is established in 2013 and its first revenue is realised in 2014;
- the company Brnica will be mainly employed manufacturing mine workers, for all the other services that are necessary for the smooth operation of the mine will benefit from synergies with Premogovnik Velenje;
- production workers, who would remain in open unemployment after the finished closure of RTH, would get employment. In the long term, at least 80 direct mining jobs are ensured in Trbovlje, while maintaining all jobs in the energy sector.

In March 2012, the management team of the company RTH calculated the effects of opening of the Brnica Mine with respect to the realisation of the programme of closure of RTH for the years 2013 and 2014. Savings in funds from the HR and social programme would amount to the total of EUR 4.25 million, which also means a significant relief for the budget of the Government of the Republic of Slovenia for the years 2013 and 2014^[6].

Legal and regulatory framework

Immediately after its establishment, the company Rudnik Brnica d. o. o. organises all activi-

ties and procedures for obtaining a concession for the exploration and extraction of brown coal in the Brnica area. In obtaining the concession, it will be necessary to consider any potential conflicts that might arise here due to the procedures related to the closure of RTH^[1]. A part of surface and mine facilities could be used for the activities of the newly established company. For this purpose, the company RTH has, with the objective of restructuring of the company, acquired a "Legal memorandum - Legal assessment of the possibility of potential obligation for repayment of received state aids upon the decision to proceed with coal mining activity", prepared by the law firm Odvetniška družba Kavčič, Rogl in Bračun, o. p., d. o. o., in September 2011. The findings in the decision are entirely related to the likelihood of a claim from EU to return the funds received from the state aid for the case of continuation of the activities of RTH and if it was another company. In both cases, the operation can be continued. The decision on the selection of the legal form of the new company will be made by the potential investors.

Activities and procedures for obtaining a concession for the exploration and extraction of brown coal in the Brnica area were prepared in the form of a legal memorandum, again by the law firm Odvetniška družba Kavčič, Rogl in Bračun, o. p., d. o. o., in March 2012. The text shows that based on the legal order in our country, an exploration permit can be obtained. In this analogy, the following documents issued by the Government of the Republic of Slovenia reasonably apply:

- The Concession Contract No. 354-14-187/01, of 27 November 2011, Government of the Republic of Slovenia, Minister of Environment and Spatial Planning, mag. Janez Kopač.
- Annex No. 2 to the Concession Contract No. 354-14-187/01, of 18 December 2011, Government of the Republic of Slovenia, Minister of Economy, mag. Mitja Gaspari.
- Permit for cessation of exploitation No. 354-15-27/2003 and 354-15-6/2004, issued on 19 January 2005 by mag. Roman Čerenak, under the authorisation No. 350-06-20/01 issued on 18 October 2004 by the Minister of Environment and Spatial Planning.

Research and analysis of domestic and global coal market

According to BRG (German Federal Institute for Geosciences and Natural Resources) data^[7] from 2009, the structure of global energy reserves that are still available consists of 24.2 % of oil, 17.6 % of gas, 4.3 % of uranium and thorium and 53.8 % of all categories of coal. Coal is the only resource among the fossil fuels that will remain in the energy market the longest, due to the large volume of reserves around the world. At the end of 2009, world proven reserves amounted to 729 Gt. At the current extent of exploitation and status of investigated global coal reserves, the availability should be sufficient for the next 200 years. Table 1 shows the prices of energy coal by months for the past twenty years.

The history of trends of coal prices in the global energy market shows that coal prices were relatively low and stable from 1992 to 2004; after this period, they increased sharply in 2008 and dropped to the price level of the year 2004 in 2009. In the last three years, they have been rising again. The coal price forecast is shown in Figure 1.

All projections and forecasts of energy coal prices indicate that they will also gradually increase in the next three years, up to 125 USD/t in 2013. This means that in forthcoming years,

the prices of imported coal in Slovenia (including transport costs on site Trbovlje) will amount to more than 4 EUR/GJ.

Another important element in the use of coal are allowances for emissions of carbon dioxide into the atmosphere; for the emissions above the limit permitted in Slovenia, they will have to be purchased in the open market in the EU. The prices of allowances for CO₂ emissions are shown in Figure 2.

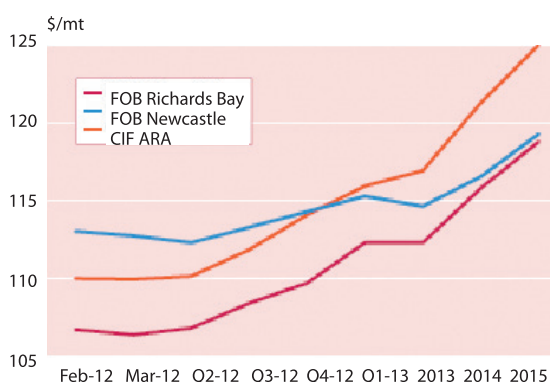
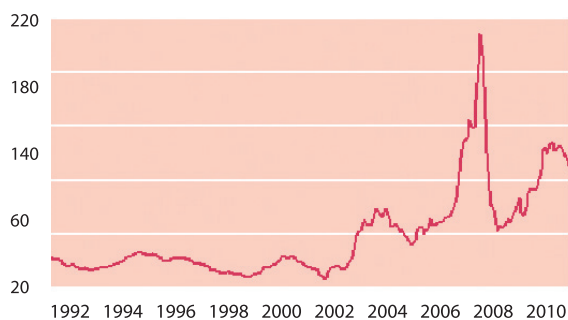


Figure 1: Coal price forecast for the period 2012–2015^[9].

Table 1: Overview of trends in world prices of energy coal for the period from 1992 until and including 2011^[8]



ICR Steam Coal Marker Price 1992 – December 2011 (Spot CIF Price, NW Europe, \$/mt basis 6,000 kCal/kg NAR)																				
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
January	42,18	34,55	34,55	42,89	43,60	41,72	35,74	29,97	30,15	41,94	34,10	36,45	67,70	70,55	54,26	68,50	130,87	78,30	86,13	124,18
February	41,66	34,51	33,99	43,38	43,52	41,01	35,39	29,66	30,30	41,08	33,10	35,49	69,94	64,41	60,62	68,87	144,70	72,00	75,40	119,38
March	40,59	33,66	35,19	43,94	42,07	41,11	32,40	29,94	33,85	41,99	33,25	33,64	66,38	66,14	64,60	72,31	139,63	61,56	73,31	125,99
April	40,57	34,45	35,23	45,10	41,03	40,82	32,24	29,22	34,81	42,98	32,75	33,09	66,23	67,00	63,75	71,69	138,69	66,25	79,38	128,25
May	40,29	34,32	36,18	45,87	39,77	39,93	31,83	29,21	34,39	42,40	28,70	34,21	67,35	65,16	60,05	72,14	158,65	63,70	89,50	122,52
June	39,69	33,11	36,26	45,75	39,49	39,12	31,52	27,84	35,13	41,41	28,60	37,13	73,86	60,91	62,64	77,10	185,00	66,31	93,63	122,80
July	37,45	32,35	37,04	45,37	39,86	38,11	31,27	26,65	36,16	39,87	27,00	39,67	77,87	62,80	62,57	78,69	208,88	67,33	92,78	123,80
August	36,45	32,40	37,51	44,96	40,31	37,75	30,43	26,68	36,20	38,22	25,98	42,67	76,52	59,16	71,02	86,60	192,65	71,50	92,66	124,78
September	35,30	32,87	38,31	44,77	40,98	37,34	30,29	27,26	37,01	37,91	30,23	47,55	74,12	58,20	65,61	95,75	170,50	68,19	92,63	123,44
October	35,87	33,53	38,93	43,85	41,09	36,98	31,46	29,17	39,56	36,00	34,28	58,80	72,10	54,90	66,19	116,25	120,00	73,30	99,98	117,58
November	36,11	34,04	40,77	44,10	41,62	36,76	30,97	28,53	41,73	35,12	34,34	61,33	77,77	52,06	67,60	128,40	92,63	77,36	107,07	114,58
December	36,16	34,32	42,22	44,01	41,67	36,38	30,49	30,39	43,07	34,50	35,01	62,02	77,06	52,24	68,10	129,62	81,25	79,70	122,38	111,27

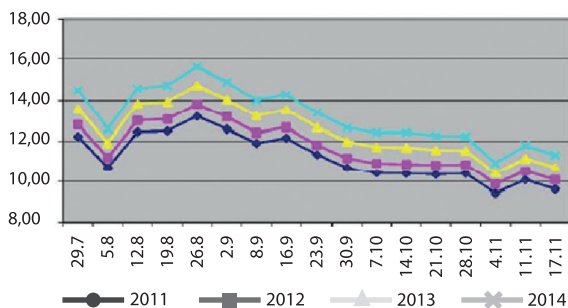


Figure 2: Futures market - prices of allowances for CO₂ emissions for the period 2011 – 2014 (EU ETS – EUR/t CO₂)^[10].

Figure 2 shows projections of prices for CO₂ allowances, which are supposed to range from approx. 10 EUR/t to 12 EUR/t in the years until 2014. According to the Figure 2, the prices of allowances are gradually falling; the most likely cause of this is certainly the nuclear disaster in Japan which has strongly stirred the thinking about energy scenarios around the world.

Macro-economic aspects of coal mining in the Republic of Slovenia

Coal mining in Slovenia is related to two power generation locations in the Šaleška dolina valley and in the Zasavje region. There are further potential or strategic coal reserves in Prekmurje. In the Šaleška dolina valley, these locations are the Velenje Coal Mine (PV) and the Šoštanj Thermal Power Plant (TEŠ). In Zasavje, the locations are the Trbovlje-Hrastnik Mine (RTH) and the Trbovlje Thermal Power Plant (TET). In the Šaleška dolina valley^[11], the national and economic importance of PV and TEŠ in view of the participation of these two companies in the broader reproduction chain of the Slovenian economy is enormous. The companies' elimination from the reproduction chain, i.e. in the event of closure of PV followed by TEŠ, would affect the main macroeconomic indicators of the Slovenian economy as a whole (GDP, industrial production, employment, foreign trade balance, price stability, etc.) and economic indicators in terms of the partial components of the Slovenian economy, i.e. industries that are related to PV and TEŠ both indirectly and directly. In this area, we can expect the impact on business performance, production, consumption of fixed capital, number of employees in companies in most industries. Long-term plans of PV and TEŠ represent a reliable link in the

electricity production chain in the Republic of Slovenia, as in the long-term (until 2054) they ensure 1/3 of domestically produced electricity.

RTH and TET are two companies that are strongly connected to the local and regional environment; their elimination from the reproduction chain would have a strong impact on the local and regional economy, but significantly less impact on macroeconomic indicators of the Slovenian economy than PV and TEŠ. TET is a strategic energy location for Slovenia that will continue to be counted on in the future^[11]. With potential options for the extension of exploitation of the remaining coal reserves in the Zasavje region in connection with their use in TET, negative demographic trends in the region would be greatly alleviated.

Coal reserves in Prekmurje represent, considering the modest reserves of fossil energy sources in our country, a strategic reserve of Slovenia^[11].

The project for exploration and opening of the Brnica area

Based on the reference points in the study "Opportunities for coal mining activities in the Brnica area"^[4], the Trbovlje-Hrastnik Mine prepared a mining project for exploration and opening of the Brnica area titled "Opening of the Brnica Mine"^[12]. The following is a brief description of required opening and exploration works.

Necessary infrastructure and capital facilities

Opening of the Brnica area is relatively simple and can be done entirely from the existing facilities at the horizon "Zvezno obzorje" in the Hrastnik mine. Both in the mine and on the surface, the entire system necessary for the smooth operation of the mine is set up. The existing surface and mine facilities that would be necessary for excavation of the Brnica mine are in a very good condition and could be used without major maintenance throughout the entire period of exploitation. In the mining project for the opening of the Brnica mine, all significant items relating to the intended exploitation

of coal in the Brnica area have been treated in sufficient detail. Figure 3 shows a three-dimensional presentation of the coal seam scheduled for excavation and the necessary facilities to access to the seam from the level of the horizon “Zvezno obzorje” of the Hrastnik mine.

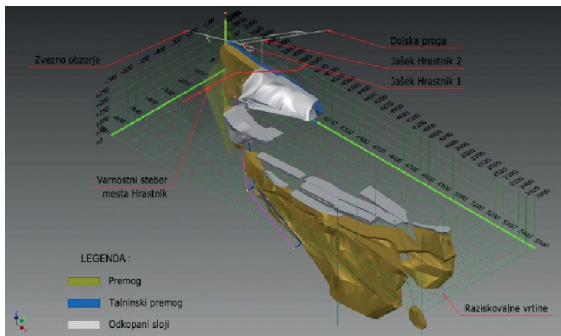


Figure 3: Opening facilities and seam disposition^[12].

Operation and excavation of the Brnica mine requires only the mine facilities. Design solutions for the opening have been prepared, i.e. the concepts of ventilation, water pumping, transport of coal, material, equipment, and people, as well as other logistics necessary for the extraction process. Mine facilities are constructed in total length of 3089 m. The scheduled opening facilities, which must be constructed up to the height point 30 and at this height point, include:

– conveyor slope, h. p. 240/170/30

Point of application of the conveyor slope h. p. 240/170/30 is planned at the horizon “Zvezno obzorje”. The length of the slope will be $L = 857$ m, and the minimum clearance gauge must be $S = 15$ m². A trough belt conveyor measuring 800 mm to 1 000 mm in width will be installed in the slope. The conveyor slope will be supported with TH arch support and lined with reinforced mesh and sprayed concrete.

– supply slope, h. p. 240/170/30

Point of application of the supply slope h. p. 240/170/30 is planned at the horizon “Zvezno obzorje”. The length of the slope will be $L = 797$ m, and the minimum clearance gauge must be $S = 15$ m². In the slope, a suspension track for the transport of materials to individual open floors. The supply slope will be sup-

ported with TH arch support and lined with reinforced mesh and sprayed concrete.

– cross-cuts at h. p. 170, h. p. 100 and h. p. 30

Connections between the conveyor slope and the supply slope will be made by means of three cross-cuts. The first cross-cut is made at the h. p. 170, the second one at the h. p. 100 and the third one at the h. p. 30. The total length of all three cross-cuts is 160 m. The cross-cuts will be supported with TH arch support, reinforced mesh and sprayed concrete, and the minimum clearance gauge must be $S = 12$ m².

– pumping station at h. p. 30

The total length of mine roadways will be $L = 75$ m, clearance gauge $S = 20$ m²; two pumps with the capacity $Q = 5$ m³/min and pumping height $H_{\text{man}} = 350$ m will be installed in the pumping station.

Roadway support in the pumping station will be made of poured concrete.

– water gates at h. p. 25

The total length of water gates will be $L = 90$ m, with clearance gauge $S = 15$ m². Water gates must accumulate an water inflow 8 h; the anticipated water inflow is 4 m³/min.

Roadway support in the water gates will be made of poured concrete.

The total length of opening facilities up to the height point 30 and at this height point amounts to 2025 m.

For the opening of the mine below the height point 30, the construction of the following mine facilities is planned (at the time of opening the Brnica mine below the height point 30, preparation works and excavation of the floor at the height point 50 will be in progress):

– conveyor slope, h. p. 30/–60

Point of application of the conveyor slope h. p. 30/–60 is planned at the height point 30. The length of the slope will be $L = 377$ m, and the minimum clearance gauge must be $S = 15$ m². A rubber trough belt conveyor measuring 800 mm to 1 000 mm in width will be installed in the slope. The slope will be supported with TH arch support and lined with reinforced mesh and sprayed concrete.

– supply slope, h. p. 30/–60

Point of application of the supply slope h. p. 30/–60 is planned at the height point 30. The length of the slope will be $L = 377$ m, and the minimum clearance gauge must be $S = 15$ m². In the slope, a suspension track for the transport of materials to individual floors will be installed (the first floor is planned at the height point 50). The supply slope will be supported with TH arch support and lined with reinforced mesh and sprayed concrete.

– cross-cut at h. p. –60

A connection between the conveyor slope and the supply slope will be made by means of a cross-cut at the height point –60. The planned length of the cross-cut is 45 m, and the minimum clearance gauge is $S = 12$ m². The cross-cut will be supported with TH arch support, reinforced mesh and sprayed concrete.

– pumping station at h. p. –60

The total length of mine roadways will be $L = 75$ m, clearance gauge $S = 20$ m²; two pumps with the capacity $Q = 5$ m³/min and pumping height $H_{\text{man}} = 350$ m will be installed in the pumping station. Roadway support in the pumping station will be made of poured concrete.

– water gates at h. p. –65

The total length of water gates will be $L = 90$ m, with clearance gauge $S = 15$ m². Water gates must accumulate an water inflow 8 h; the anticipated water inflow is 4 m³/min. Roadway support in the water gates will be made of poured concrete.

The total length of opening facilities below the height point 30 amounts to 1 064 m.

Preparatory works

After conducting exploration works, it will be possible to begin placing the excavation fields in the seam^[13], in a manner that will ensure maximum yield of the seam and thus minimum excavation loss. Mining fields must allow excavation according to the principles of the longwall mining method with sublevel caving. Preparatory facilities will be mainly used for a very short time; it is important for them to be cost-optimal and provide functionality during

the preparation and excavation without major additional maintenance activities. Mining fields must be ventilated with flow mode, even separately if necessary. The conveyor track must be constructed with the fewest possible refraction points, possibly in more favourable geomechanical conditions. In the event of the need for tilting the coal faces, they should be tilted from the supply side to the conveyor track and with a downward slope in the direction of the coal face advance.

Given that all preparatory facilities will be entirely constructed in coal, the construction of these facilities will be carried out mechanically, by means of advance loading machines and continuous conveyance of excavated material. The mine facilities will be supported by steel arch supports, either open or closed, in combination with bolts if necessary. The siding will be made of mesh - either iron or nylon - or timber. In case of danger of spontaneous combustion of coal, insulation lining will have to be made. Progress in the construction of such facilities is 4–12 m/d, depending on the geomechanical conditions, construction technology and organisation of work.

The coal mining process

Depending on the location, shape and thickness of the seam as well as the characteristics of hanging wall and footline, it will be reasonable to use the highly productive longwall mining method with sublevel caving. The length and the width of the excavation floors will have to be maximum, depending on the dimensions of the seam, and the heights of excavation will be able to amount to up to 15 m and will depend on geomechanical and hydrological characteristics of the hanging wall seams. When sizing the floors, it is also necessary to consider the impacts of the excavation on the surface.

The technology of coal face excavation by using the longwall mining method with sublevel caving consists of two separate stages: In the first stage, the mine facilities are constructed and coal is excavated from the footline, followed by the stage of pouring of coal from the hanging wall section of the coal face. Depending on the geomechanical properties, an adequate number of shifts of the conveyor and arch support is made, followed by the stage of exploitation

from the hanging wall section. During footline formation, there is a consecutive sequence of cutting the upper cut with the shearer, supporting the excavated space, cutting the lower cut and shifting the conveyor and hydraulic support. At the same time, intersections on the supply and conveyance side must be constructed. Extraction of coal from the hanging wall consists of pouring of coal in front of the sections or through openings in the shields of the hydraulic support. If necessary, crushing and crumbling of coal by blasting can also be performed. If the coal face is 45 m wide and 15 m high, the excavation loss amounts to 10 % and the volume mass of coal is 1.45 t/m³, then approximately 680 t of coal is produced from one 80 cm deep cut. Depending on the organisation of work, an average of up to 6 cuts can be carried out daily.

For the process of excavation, it will be sensible to use technical solutions provided in the mining project for the implementation of works: "Mining method in the Trbovlje-Hrastnik Mine"^[14].

Drainage

All the water from the excavation floor as well as other mine facilities will be gravitationally channelled to the height point 30 and height point -60, where two pumping stations will be located. From the pumping stations, the water will be pumped in pressure pipelines to the horizon "Zvezno obzorje"; the pressure pipelines will be installed on the conveyor slope.

It is necessary to drill drainage holes in the limestone at the height points 30 and -60, and pump as much water from the limestone to maintain the level of groundwater in the limestone always at least 10 m below the level of the floor in the process of excavation. The expected inflow of water in the mine amounts to 4 m³/min.

Ventilation

The required volume of ventilation in one excavation floor is 480 m³/min. Fresh air inflow will be entering the mine from the surface down the Barbara slope to the level of the horizon "Zvezno obzorje", and then in the direction of the conveyor slope to the excavation floor. The used air will be led along the conveyor slope to

the horizon "Zvezno obzorje", to the Javor hanging wall and further to the Javor fan station.

Transport of coal, materials and people

Coal will be transported from the floor in the direction of the conveyor slope, to the horizon "Zvezno obzorje" and to the separation site. From the floor to the separation site, 5 conveyor belts with automatic control mode would be installed for coal transport.

Materials and people would be transported from the surface to the floor by means of a suspension diesel engine. The length of the entire transportation route will be between 2 500 m and 3 000 m.

Measures to ensure the safety

When opening a mine or excavation field of the Brnica area, it is necessary to consider the measures listed in general projects taken from RTH and also the provisions of the mining project for opening works, general instructions and prescribed measures for safe work.

Environmental impacts

The implementation of preparatory, opening and excavation works in the mine will have a certain impact on the environment; first of all, the level of groundwater in the rock mass will decrease, and influences in different forms will also be reflected on the surface. The decreasing level of groundwater will also result in potential emptying of caverns in the rock mass. This can lead to instability of the ground on the surface in the form of small slips or wrinkling. Other major changes on the surface due to lowering of groundwater are not expected.

According to the experience of excavation in RTH, the settlements resulting from the excavation within the caving area will amount to a few meters and to several 10 cm in the influence area. Such changes on the surface could affect the change in terrain, increasing the possibility of migration of rainwater towards the coal face, a decrease in stability can be expected in the lower part of southern and south-eastern area. The possibility of erosion will also be increased, especially in the steep part of the surface where crumbling of rocks can occur.

The implemented technological processes of direct rehabilitation of cracks and other impacts of mining on the surface will, in addition to providing safe excavation in the mine, influence an improved appearance of the surface; they will ensure safe movement of workers, machinery and transport equipment and represent the basis for the implementation of primary recultivation of the area. Recultivation works will prevent any excessive and prohibited negative impacts on the environment.

Rehabilitation, recultivation and spatial planning

According to the assessment and experience from RTH, there will be no facilities on the surface endangered by the impacts of exploitation in the mining area (area with concession). At the very edge of the area, there are two potentially affected objects, but do not represent a significant amount of purchase cost. The settling of the area will be handled promptly, according to the existing regime in RTH. In order to improve appearance and prevent erosion, grass is sown on temporarily rehabilitated surfaces.

Economic evaluation of investments

Methods for the evaluation of investments

For the economic evaluation of the project, we selected three methods of evaluation of investment projects according to Runge^[15] and the NSW project^[16], namely the net present value method (NPV), internal rate of return method (IRR) and the payback period method (PBT).

The net present value method of the project estimates the economic success of the investment project in the light of future returns of invested assets and means the sum of the values obtained by discounting the net inflows of the project at a certain selected discount rate to their present value. The required rate of return for the calculation of the cash flow was calculated on the basis of the weighted average cost of ordinary shareholders capital (WACC). The cost of ordinary capital is calculated according to the capital assets pricing method (CAMP). The model rests on the premise that the inves-

tor requires a higher return on investment at a higher level of risk.

The internal rate of return method represents the real interest rate for the money that has been or will be bound up over the lifetime of the investment. This is the interest rate at which the net present value of an investment is equal to 0. The method is usually used as an additional judgement in deciding on the choice of one of two competing projects.

Payback period method of the investment is the time necessary for income to cover the full amount of the investment costs. PBT unlike NPV and IRR is not a dynamic method because it does not take into account the time value of money. PBT in this form only serves as the comparative method.

Basis for the evaluation of the Brnica project

As a starting point for the calculations we took into account the assumptions of the study "Opportunities for coal mining activities in the Brnica area"^[4], assumptions of the study "Preparation of a business model and options for its application in establishing and organising a mining company"^[11], the mining project "Opening of the Brnica Mine"^[12] and the Decree on mining concession fee and funds for rehabilitation^[17]. The basic assumptions underlying the projections of financial statements presented below are summarised in the following points:

- the owners provide share capital amounting to EUR 4.5 million in 2013 and an additional amount of 1.5 million in 2014;
- in 2013, the purchase of buildings, mine facilities and equipment from RTH is made in the value of EUR 3 million;
- in 2013, an investment in the preparation of the exploitation is planned in the amount of EUR 7.3 million, followed by EUR 0.64 in 2014 and approximately EUR 0.51 million in the years from 2015 to 2020. Throughout the period of operation of the mine, further investments in equipment are planned in the total amount of EUR 18.7 million;
- the remaining value of fixed assets at the end of the year 2034 is estimated at EUR 2.15 million;
- all assets from depreciation and amortisation will be written off during the period of operation of the mine. In all cases the linear

- depreciation method was used, the annual depreciation rate will be 6.67 % until 2020. In case of equipment purchased by the year 2025 the annual depreciation rate of 10 % or 12 % were taken. For purchases from 2026 onwards the annual depreciation rates of 11 % until 2033 and 50 % after 2033 were used;
- the average number of employees in the direct production will be 67 or 54 during the first and last year of the mine respectively, and 80 in the periods in between. The expected 20 % absence from work will be compensated by hiring additional labour; costs were accrued among the costs of production services;
 - cost of upgrade services (Commerce, Finance and Accounting, Design Engineering and other management or administrative work within the general activities) are evaluated at an average of EUR 625 000 per year and are disclosed in the company's non-production costs as expenses of the period;
 - the planned quantity of coal production will be 26 000 t in the first year, 24 000 t in the last years and 310 000 t per year in the period from 2014 to 2033. In the period from 2013 to 2034, the total of 6.25 Mt of coal with average heating value of 12.10 GJ/t will be excavated;
 - the sales will amount to 26 000 t in the first year, 300 000 t per year in the period from 2014 to 2033, and 224 000 t in 2034;
 - the planned selling price of coal should remain constant throughout the entire period of operation of the mine, i.e. 2.60 EUR/GJ;
 - From 2014 to 2033, coal stocks will increase by 10 000 t per year, and in the final year 2034, the disposal of all stocks together with current annual production is expected. The unit value of coal in stock is evaluated according to the production costs method;
 - the interest rate for long-term and short-term loans received amounts to 6 % p. a. The same rate is also taken into account when discounting cash flows to calculate the net present value of the entire project;
 - the interest rate on short-term deposits is 1.5 % p. a.;
 - Value Added Tax (VAT) is not included in the projections of financial statements, as it has a neutral impact on the cash flows;
 - furthermore, the corporate income tax (corporate income tax) is not calculated in the projections, as it is expected that the Company will, in accordance with the predicted amendment of Article 55.a of the Corporate Income Tax Act (ZDDPO-2), be able to claim deductions for investments (i.e. 40 % of the amount invested or up to the amount of the tax base), which will make the basis for corporate income tax in a given tax period equal to zero.

The entire project is evaluated on the basis of fixed prices for April 2012. A summary evaluation of the investment project Brnica for the entire operational life of the project is shown in Table 2.

At a 6 % discount rate, the net present value of cash flow is positive and amounts to EUR 3 216 551. The invested funds are reimbursed after 15.4 years. The internal rate of return amounts to 8.6 %, which means that at this interest rate, the investment expenditure would equal the returns.

As the final value of the project, we considered only the value of the balance of deposits at the end of 2034, less EUR 4 million for precautionary reasons.

In the years 2035 and 2036, the Company with its own sources of funding carries out a rehabilitation of the mining area, disposes of fixed assets, the residual value of which is estimated at EUR 2.15 million and settles all of its obligations. After carrying out a technical inspection of the performed rehabilitation, the Ministry notifies the Eco Fund which makes a calculation of the funds reserved for the rehabilitation; based on the final decision of the Ministry to terminate the rights and obligations of the concessionaire, these funds are returned to the concessionaire's bank account. It is estimated that after the final liquidation of the company, approximately EUR 18.2 million would remain for the owners.

Table 2: A summary evaluation of the project "Brnica"^[11]

in EUR	Rudnik Brnica d. o. o.		
	Cash flow	Discount rate	Present value
2013	(7555 370)	0.94	(7 127 708)
2014	435 500	0.89	387 593
2015	813 600	0.84	683 114
2016	623 700	0.79	494 029
2017	223 700	0.75	167 162
2018	(3076 300)	0.70	(2 168 670)
2019	(76 300)	0.67	(50 744)
2020	223 700	0.63	140 352
2021	1 312 300	0.59	776 748
2022	1 347 600	0.56	752 493
2023	1 347 600	0.53	709 899
2024	1 347 600	0.50	669 716
2025	1 247 600	0.47	584 924
2026	347 600	0.44	153 744
2027	847 600	0.42	353 674
2028	1 347 600	0.39	530 478
2029	1 347 600	0.37	500 451
2030	1 347 600	0.35	472 123
2031	1 347 600	0.33	445 399
2032	1 447 600	0.31	451 369
2033	1 487 600	0.29	437 586
2034	1 983 780	0.28	550 509
Final value	11 900 000	0.28	3 302 311
Present value			3 216 551
Initial investment			0
Net present value			3 216 551
Weighted average capital cost			6.0 %
Internal rate of return			8.6 %
Modified internal rate of return			7.4 %
Payback period			15.4 years

Conclusion

Mining is related to electricity production in TET. We believe that opening of the Brnica Mine and establishment of the company is a realistic, if not even necessary, option for provision of coal at a competitive price of 2.6 EUR/GJ for further operation of TET. Imported coal could continue to be purchased by TET at a price of more than 4 EUR/GJ, but the thermal power plant would most likely not be able to handle such costs. The investment in the opening works in the mine is relatively small. An assumption for the operation of the new mine is based on the annual production of 310 000 t of coal in 20 years or the total excavation of 6 250 000 t of coal. The economic evaluation of the project was conducted by using three methods for valuation of investment projects; all considered criteria have resulted in a positive assessment of the investment performance. The jobs that could be preserved in this way in the mining and energy industry would substantially improve the negative demographic trends in the otherwise heavily worn-out Zasavje region.

References

- [1] Zakon o postopnem zapiranju Rudnika Trbovlje-Hrastnik (RTH) in razvojnem prestrukturiranju regije (Uradni list RS, št. 61/2000).
- [2] Berger, Aleš. Strateške usmeritve in vizija v procesu zapiranja in prestrukturiranja poslovnega sistema Rudnik Trbovlje-Hrastnik : magistrsko delo. Ljubljana 2011.
- [3] Zelena knjiga za Nacionalni energetske program Slovenije, Ljubljana, 2009.
- [4] Dervarič, Evgen s sodelavci: Možnosti za izvedbo odkopavanja premoga v območju Brnica: študija. Ljubljana: Univerza v Ljubljani, Naravoslovnotehniška fakulteta, junij 2011.
- [5] Vukelič, Željko s soavtorji: Geological evaluation of brown coal reserves at the Hrastnik mine - RTH, Rudnik Trbovlje-Hrastnik = Geološka evalvacija zaloga rjavega premoga na območju jame Hrastnik - RTH, Rudnik Trbovlje-Hrastnik. RMZ-mater. geoenviron., 2010.
- [6] Dervarič, Evgen. Revizijsko poročilo: Srednjeročni program zapiranja Rudnika Trbovlje-Hrastnik III. faza (2010–2014), novelirana izdaja Ljubljana: Naravoslovnotehniška fakulteta v Ljubljani, februar 2011.
- [7] Annual Report-Reserves, Resources and Availability of Energy Resources 2010, obnovljeno dne 9. 10. 2011 na <http://www.bgr.bund.de>.
- [8] World Energy Outlook 2011, International Energy Agency, OECD/IAE; Paris, 2011.
- [9] Platts, ICR Coal Statistics Monthly, January 9, 2012.
- [10] EURACOAL, European Association for Coal and Lignite: Market Report 2/2011, December 2011.
- [11] Dervarič, Evgen s sodelavci: Priprava poslovnega modela in možnost njegove aplikacije pri ustanovitvi in organizaciji rudarskega podjetja – Rudnik Brnica: študija. Ljubljana: Univerza v Ljubljani, Naravoslovnotehniška fakulteta, maj 2012.
- [12] Rudarski projekt: »Odpiranje jame Brnica«, št. projekta B/01, Trbovlje 2012.
- [13] Interna dokumentacija RTH – Rudnik Trbovlje-Hrastnik, d. o. o.
- [14] Rudarski projekt: "Odkopna metoda Rudnika Trbovlje-Hrastnik" št. projekta 2817, Trbovlje, november 2007.
- [15] Runge, Ian C., Mining Economics and Strategy, Society for Mining, Metallurgy, and Exploration, Inc. Littleton, USA, 1998.
- [16] Technology and Feasibility of Potential Underground Thick Seam Mining Methods, UNSW/CMTE Collaborative ACARP Project (C8009) – Final Report, Australia, 2002.
- [17] Uredba o rudarski koncesnini in sredstvih za sanacijo (Ur. l. RS št: 91/2011).