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THE POSSIBILITIES AND CHANCES OF THE PROJECT ENERGY COMPLEX KOVIN — NEW COAL MINE AND POWER PLANT

1. Introduction

The first geological studies in Kovinski basin started in 1976 to 1979. The results of these studies showed the presence of interesting economic coal beds. Coal is of such quality that can be used in thermal power plants. The entire studies took place in stages that are aimed at determining the quantity and quality of coal required to open the power plant. Due to the specific areas and great influence of underground water, the experimental test pit was opened on the banks of the Danube. In this pit method that was used is underwater mining of coal, and this method proved to be an alternative to dry mine Kostolac the other side of the Danube. Due to the specific conditions in the protected part of the deposit fields A and B, were considered two types of mining coal: dry open pit mining and underwater.

2. General part

2.1. Geographical location

In geographical terms Kovin coal deposit is situated about 50 km east of Belgrade, in the municipality of Kovin, in the villages Malo Bavanište i Beli Breg and it is bounded by the Danube on south, line Dubovac-Gaj on north, Deliblato- delta river V. Morava to the west and village Gaj to the east.

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2.2. Communication

Kovin coal basin considering to communication opportunities in this area has a very good position and connections to other places in vicinity.

Through the exploration area goes way abouth 5 km long, partly paved and partly gravel road, which connect experimental underwater mine Kovin with the settlement Gaj.

Close to exploration area on north there is a regional way Bela Crkva — Dubovac — Gaj — Kovin through which this region is associated with major regional, provincial and national centers (Fig. 1).

Fig. 1. Map of communication with the position of exploration area

The closest link with the motorway Belgrade — Niš this area has an asphalt road over Smederevo (about 15 km) where are the nearest rail loading stations.

One of the most important communication links in this area is the Danube itself, so the majority of products and raw materials in this area is transported by water, as the cheapest form of transport.

2.3. Climate characteristics

At exploration area of coal deposit and in wider area prevails slightly changed moderate - continental climate characterized by dry, hot summers and cold and wet winters, but is one of the most important features and a very pronounced effect of the southeast wind — Košava especially in the winter.

In this area there for many years, in many places, made Hydrometeorological observations (measuring station: Belgrade, Smederevo, Kovin, Bela Crkva, Pancevo, Zrenjanin, etc.).

The basic characteristics are that the temperature difference can range from very low in the winter period (up to − 25 °C) to very high in summer (up to 39 °C), with an average humidity around 80% in the winter and about 60% in summer (annual average about 67%).

2.4. Description of the actual land-use

The area of the prospected mine site "Novi Kovin" is mainly used as arable land. Field crops and various types of cereals and corn are produced. All fields are under production, no areas of set-aside land have been found. The sizes of the fields differ from over 40 ha to small sizes of a few hundred square meters. For fertilizing ground bones and claws are used on some fields as biological fertilizer. This indicates a low usage of mineral fertilizer. Pasture farming is limited to small flocks of sheep and goats on the Danube River dam and some single cows.

The infrastructure is based on country lanes without pavement. The connection of the fields is acceptable. A paved road connects the small villages Malo Bavaniste and Beli Breg.

Due to its function as productive arable land, trees and bushes are limited to the channels. Specialized biotopes can be expected only along the channels. The soils are mainly loamy-sandy with areas enriched with clay. Together with the connection to the groundwater, productive soils exist on the prospected mine site.

The soils are formed by the river Danube. They are alluvial sediments and differentiate into "Aluvijum — facija povodnja: peskovi I alevriti" and "Aluvijum — facija staraca: barski peskovi I alevriti". The last one is originally a swamp soil with high humus content. The grain size of both soil-types are silt to very fine sand. A small area at Beli Breg is formed by "Eol sand morfologicly unformed". They are characterized with a lower water retention capability and therefore more dry conditions in the summer months.

2.5. Settlements

In total two villages, Malo Bavaniste and Beli Breg, exist in the area with approximately 300 inhabitants. The settlements are connected by a paved road to the village Gaj outside the prospected area. They are typical rural farmer villages without any commercial area. Malo Bavaniste has a Post-office and a small shop. Some of the small farmhouses in a good repair others are not. A well kept cemetery is close by. In an area without lignite in the underground in the centre of the field a church and a cereal storage exists.

Fig. 2. Fields between the villages Gaj and Malo Bavaniste 11.11.2010 (LMBVi)

3. Review of activities

3.1. Geological exploration

The first written records of geological surveys and studies of Banat date from second half of the 19th century, J. Kalovača (1880, 1883–84, 1887), later, J. Čolnoki (1907), J. Cvijić (1924), B. Milojevic (1949), J. Markovic-Marjanovic (1949–1950) and many other authors perform geomorphological research in this area.

All these geological investigations were mainly litho — stratigraphic and structural geological and did not address the issue of the appearance of coal.

Under the Basic geological map, 1:100 000, list of Bela Crkva, M. Rakic (1975) first indicated the occurrence of coal beds on the left bank of the Danube.

Based on this results in 1977 first systematic geological explorations have been organized, with aim to determinate geological conditions of productive coal beds with rare net of drill holes, in this so called first phase of geological explorations.

Results were positive and indicate realisation of second phase in 1977 to 1978 where coal deposit was confirmed.

Based on the results of the above studies it was concluded that are economically significant coal reserves developed in two layers. The amount of estimated coal reserves was about 400 milion tons of lignite coal, in area of 65 km^2 which are similar to C_2 category reserves.

Further research, carried out in the second half of 1978 aimed to re-categorization of coal reserves of deposit from the lower category to a higher C1 category of reserves. In this research deposit was divided into two productive fields, west field "A", with an area of about 15 km^2 and the east field "B" area of 17 km^2. It was also found that between this

fields there are barren zone as a result of the structural position of coal beds, and not their primary source.

With the definition of coal reserves in the deposit, a significant result of this research was determining the distribution and classification of layers, and to precisely determine the barren zone between the coal fields. First coal seam in the western part of the field "A" splits into two, upper one named Ia, and lower, most perspective, named I-Ib. In the field "B" first seam is unique without branching and because of corelation with layer in field A it was also called I-Ib.

Second coal seam was uniquely developed in both fields but decomposed with inter slice tailings.

At about the same time, the study level have begun considering possible solutions for valuation of coal from deposit. For more complete perspective of layer, hydrogeological and engineering — geological events during 1980–1981 in the deposit were carried out additional studies, complex applications, all within the preparation of "Investment program to build coal surface mine Kovin — South Banat for the thermal capacity of 600 MW" in fields A, transition (reactive) zone and the field B.

All geological studies in the "protected" area of deposit during this period were conducted based on the concept of opening the coal mine for power plant Kovin total capacity of 600 MW.

The division between "protected" and "unprotected" part was "artificially" created as a result of embankment construction.

Based on deposit conditions, especially hydro, with established high water-bearing consideration of the concept of the underwater exploitation of coal has begun.

Further development of the concept of the underwater exploitation of coal and coal reserves estimated in the coastal field "A", carried out new research in 1984 from 18 exploration boreholes and complex laboratory tests.

This research has served to localize the area field in the opening zone of field "A" for the trial phase of underwater coal mining.

During 1986 detailed exploration drilling was carried out with all necessary labaratory tests, with aim to form geological and engineering-geological basis for the preparation of the mining project. Based on this reserves in 1991 began underwater coal mining and related raw materials, sand and gravel, which continues to this day.

During 2008, based on the approval of the Secretariat of Energy and Mineral Resources (No. 115-310-00070/2008-02) geological exploration were carried out in the protected part of the "field A" and "B" to the extent of 23 exploration boreholes.

The main objective of this study was to determine the northwestern and western boundaries of the field "A" and thick investigative network and recategorisation of coal reserves in the "B".

In addition to obtaining new geological data from this region one of the objectives was to establish a complete monitoring of the groundwater regime in all three water-bearing horizons as recommended by the Institute for the Development of Water Resources "Jaroslav Cerni".

Results of research conducted 2007 and 2008, together with details of all investigations carried out so far in the protected and partly in the unprotected parts of the field “A” and “B” are the subject of making Study on reserves of coal in the Kovin coal basin — fields “A” and “B”.

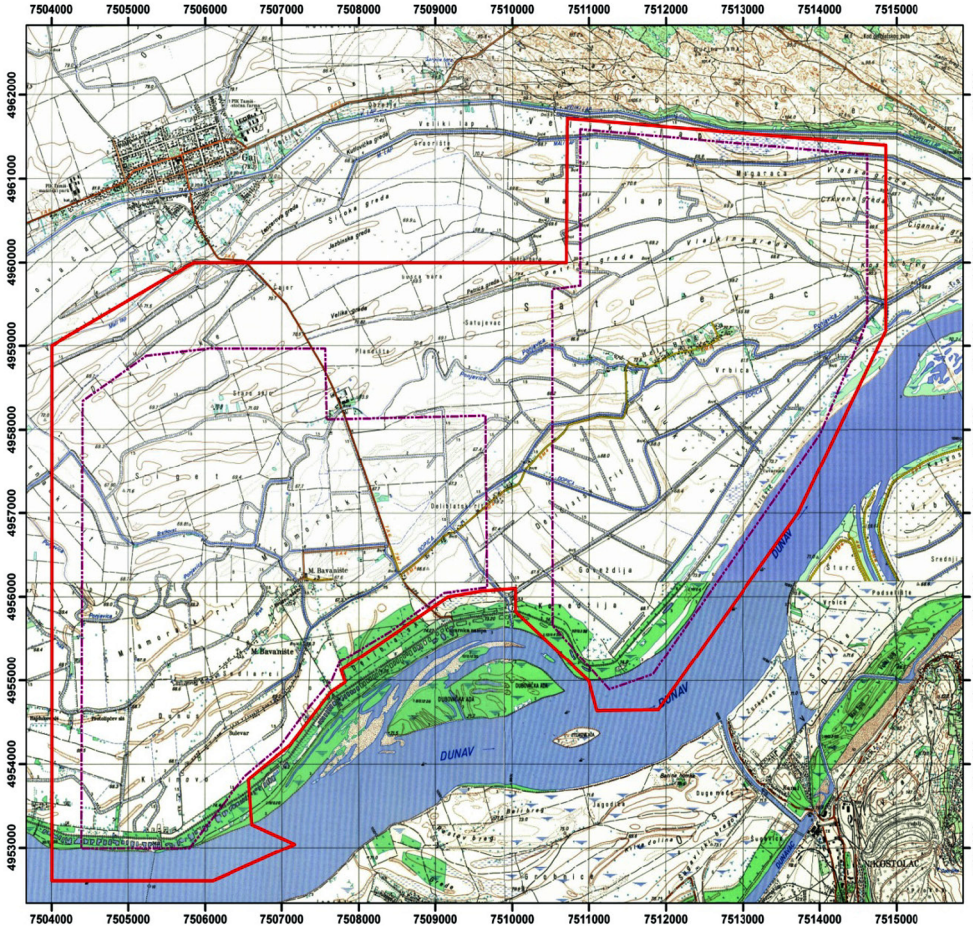

Fig. 3. Survey topographic map with the position of exploration area — Kovin coal basin, fields “A” and “B”

Coal reserves with following quality were estimated — table 1–4.

3.2. Investment programs

On the basis of previous studies there is a possibility of building and the capacity of 600 MW.

TABLE 1

Total reserves

Field	Coal seam	Category	Balance reserves, m^3	gu, t/m^3	Balance reserves, t
“A”	Ia	B	8.763.438	1,2	10.516.126
		C_1	4.342.862		5.211.434
		B + C_1	13.106.300		15.727.560
	I-Ib	B	48.164.691	1,24	59.724.217
		C_1	7.460.059		9.250.473
		B + C_1	55.624.750		68.974.690
	II	B	18.751.439	1,26	23.626.813
		C_1	3.762.261		4.740.449
		B + C_1	22.513.700		28.367.262
	total	B + C_1	91.244.750		113.069.512
“B”	I-Ib	B	9.110.400	1,25	11.388.000
		C_1	27.045.900		33.807.375
		B + C_1	36.156.300		45.195.375
	II	B	9.949.940	1,28	12.735.923
		C_1	9.097.510		11.644.813
		B + C_1	19.047.450		24.380.736
	total	B + C_1	55.203.750		69.576.111
“A + B”	sum	B + C_1	146.448.500		182.645.623

TABLE 2

Weighted value of technical analysis of coal

Field	Moisture, %	Ash, %	S uku., %	S pep., %	S sago., %	Koks, %	C-fix, %	Isparlj., %	Sagorlj., %	DTE, kJ/kg	GTE, kJ/kg
“A”	42,68	17,51	1,11	0,56	0,55	34,17	16,72	23,14	39,75	8 891	10 351
“B”	42,27	17,88	1,10	0,45	0,64	33,63	15,91	23,23	39,76	8 634	10 528
“A” + “B”	42,47	17,69	1,10	0,51	0,60	33,90	16,32	23,19	39,76	8 763	10 439

TABLE 3

Weighted average values of elemental analysis of coal

Field	Carbon, %	Hydrogen, %	Sulfur comb., %	Nitrogen and oxygen, %
“A”	26,28	2,38	0,55	10,68
“B”	25,55	2,33	0,71	10,36
“A” + “B”	25,92	2,35	0,63	10,52

TABLE 4

Mean weighted value of the chemical composition of coal ash

Field	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	SO_3	P_2O_5	TiO_2	Na_2O	K_2O
“A”	43,75	11,38	17,20	12,70	3,44	9,35	0,13	0,58	0,60	0,97
“B”	47,51	10,47	18,63	10,37	2,74	7,83	0,09	0,65	0,58	0,79
“A” + “B”	45,62	10,93	17,91	11,54	3,09	8,60	0,11	0,62	0,59	0,88

Coal in this deposit belongs to the class of soft brown coal — lignite with an average value of the lower thermal effect of both coal layer about 8 000 kJ/kg, which corresponds to lignite primarily used to generate electricity.

During the eighties long-term energy policy in the province of Vojvodina and passed a long-term development plans ("Concept of Development of SAP to 2000") was established in which Kovin coal has key role in the implementation of the adopted. Also energy complex was adopted in Energy Development Strategy of Serbia (2007–2012), as well as the Spatial Plan of Serbia until 2020 year.

For understanding the geological and exploitation conditions in the Kovin coal deposit and decision making on the method two investment programs were performed for the exploitation of deposit.

The investment program of building surface coal mine Kovin — south Banat for 600 MW power plant was done based on certified reserves from Kovin deposit in 1980.

Difficult conditions of exploitation with conventional open pit mining technologies (large quantities of groundwater) caused to be considered otherwise mining method.

A study on the possibility of coal mining through underwater was made, and then in 1982 The investment program "Underwater exploitation of coal deposit Kovin A field for the TE Kovin 600 MW" (Hidrobiro, Novi Sad). Innovation and actualization of the program was done in 1988.

Comparative analysis of the investment programs for mining both variants showed (economic indicators, designed technological solutions, the priority of environmental protection and the valorization of coal reserves) that underwater mining technology has priority.

In order to prove the selected technology, it was decided to approach the implementation of Phase I of underwater operation, the experimental character, which would enable to obtain complete data for the construction of underwater coal mine.

3.3. Experimental underwater mine Kovin

The current area of coal and gravel mining is located in southern, coastal unprotected, part of field A between the embankment and the left bank of the Danube.

The basic machinery and equipment used for excavation of coal is dredger with cutting wheel UCW 450 and transport equipment, pipelines (dredging, water and land), installation of drainage and grading of coal and coal processing plant from settling basin.

So far it has been produced and sold over 2 million tons of coal with a value of about 10 000 kJ/kg DTE, mostly for household consumption and partly for boiler plants and power plants, and over 5 million cubic meters of gravel.

The mine exploits the 600 000 tons of gravel and 450 000 to 500 000 tons of coal annually. Coal is lignite, whose production characteristics are: calorific value of 9 000 to 12 500 kJ, below 0.7% of the combustible sulfur and 6–15% of ash. Moisture content of coal varies between 42 and 50%. The high level of moisture was the result of underwater exploitation, hydraulic transport and geological conditions of deposit.

Fig. 4. cutting wheel dredger UCW 450

Fig. 5. Mine view

4. Current activities of the project

After obtaining certification of coal reserves in the Kovin coal basin investor launched a series of activities related to obtaining approval for exploitation. Beside activities described in mining law next activities were determined: selection of the optimal mining method, the possibility of coexistence of coal and a potential regional sources of drinking water, possibility for Public Private Partnership.

4.1. Selection of the optimal mining method

The program is implemented in order to select the optimal method of exploitation by analysis of variants of surface and underwater exploitation at the level of conceptual solutions for the construction of the optimum capacity of power plant.

The favourable mining method depends on the configuration of the deposit. The lignite seems are affected from the glacial period, but stratified planar-horizontal. The excavation is therefore possible with large items of mining equipment. For an economic feasible working process the decisions of an open pit mine or a wet dredging and the most feasible excavation equipment has to be taken. Different types of the horizontal cutting heights and angles of intersection (direction of extraction) of the large extractors define the working face. Under 5.2-2 different wet- dredging types will be explained.

Both technological systems have there pros and cons. The impact to the environment in total is lower with the wet-dredging system. The influence of the mining project to the environment is a minimum in comparison with a dry open-cast mine. The existing mining project of the experimental Kovin mine shows that the land-use developed over decades could exist and also the nature of the Danube River banks. An open-cast mine beside the Danube River needs an extended sealing wall and extended pumping with well galleries around the mine. This will have a deep impact on the groundwater flux in the aquifers and the cone of depression will cover an area several times larger than the mine itself. The size depends on the permeability of the groundwater layers. The groundwater quality after flooding the open-cast mine is different from the origin. Through the aeration processes during the groundwater lowering oxidation processes occur and acids and salts are developed.

4.2. The possibility of coexistence of coal and a potential regional sources of drinking water

As previously indicated, planning documents (Spatial Plan, Water Management Master Plan...) designate the Kovin Depression as an area for the development of a regional groundwater source, for the extraction of coal which is the primary mineral resource in Vojvodina, and for the construction of a thermoelectric power plant.

In view of the fact that the future groundwater source will tap the “first” aquifer formed within alluvial gravels of the Danube, and that the specific coal extraction method will result in permanent — physical degradation (alteration) of the previously-described setting (porous medium) in which the aquifer is found, it is necessary to address the conditions and constraints under which these two important resources can be exploited in the Kovin Depression.

The impact of underwater coal mining on the groundwater source will be reflected in the groundwater regime, or groundwater quality and quantity.

With regard to coal mining, it is evident that the development of coal mining fields “A” and “B” will create a direct hydraulic contact between the “first” and sub-artesian aquifers within Pontian strata. In view of the quality and quantity of water which will be infiltrated into the “first” aquifer, this impact is of no special interest. However, excavation of the

gravelly-sandy alluvial stratum, and disposal of mullock within the excavated area, will considerably reduce groundwater flow from the hinterland to the groundwater source. Since excavation will be limited to fields A and B, the impact of the New Kovin underwater mine on the overall capacity of the Kovin-Dubovac groundwater source is expected to be 10–15%.

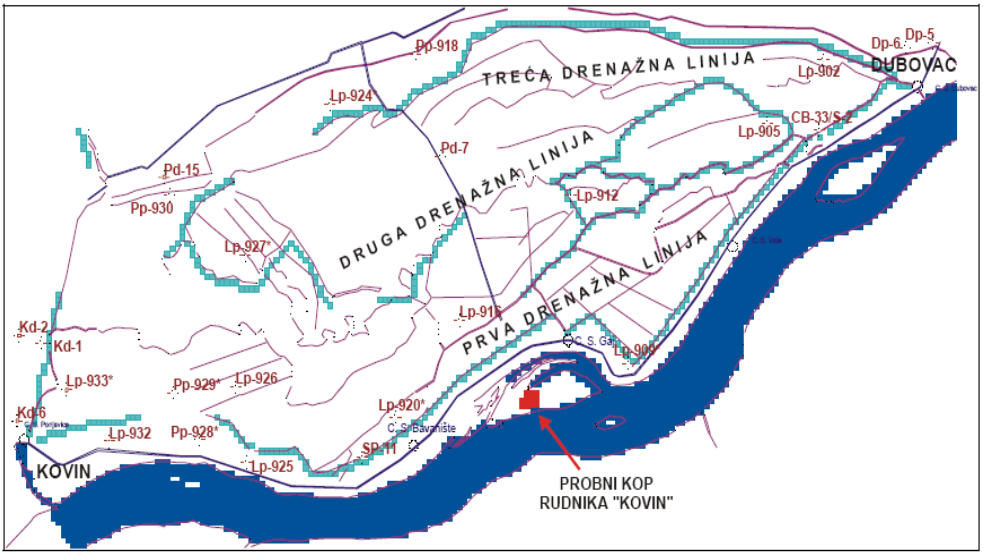

Fig. 6. Schematic map of area between Kovin and Dubovac with the channel system (Institute Jaroslav Cerni)

However, with regard to the impact of the mine on the quality of groundwater at the source, and its potential degradation, a series of conditions and constraints will have to be imposed to protect natural groundwater quality.

The constraints should primarily address the locations and technical characteristics of infrastructures, and the types and manner by which raw materials that can contaminate groundwater are stored, used in the production process, and dumped.

To prevent groundwater quality deterioration, a natural safeguard zone will have to be established between the mine (thermoelectric power plant) and the water wells. An undisturbed belt of gravel and sand will allow for positive groundwater quality transformation during groundwater flow.

The width of this belt will depend on the characteristics of the porous medium, groundwater flow velocity, and pollutant residence time. Based on the Regulation on the Designation and Maintenance of Drinking Water Source Safeguard Zones (Official Gazette of the RoS 92/08), the present level of assessment suggests that the width of the belt should be about 200 m (to be defined and documented during the course of development of design documents).

4.3. Posibility for Public Private Partnership

"Ciljevi realizacije projekta, mogućnosti i koncepta JPP-a su da se definišu prava i obaveze partnera u realizaciji infrastrukturnog projekta u oblasti energetike" The objectives of the project, the possibilities and the concept of Public Private Partnership (hereinafter referred to as PPP) are to define the rights and obligations of partners in the implementation of infrastructure projects in energy sector "Novi Kovin i definiše model po kojem će se izvršiti JPP". "Novi Kovin" and to define a model by which PPP is to be carried out.

"Od realizacije projektnog zadatka se očekuje da se definiše model po kojem će se izvršiti JPP, i realizovati infrastrukturni projekat u oblasti energetike Novi Kovin" .The implementation is expected to define the model by which PPP is to be carried out, and to implement infrastructure project in the field of energy "Novi Kovin".

PPP is one of the best models for attracting capital in sectors such as energy, environment, tourism, and especially for privatization of public utility enterprises, and infrastructure. The concept of PPP in Serbia provides the possibility to realize the projects for which the state does not have enough money during the crises.

Cooperation between public and private sectors in the energy sector through the concept of PPP provides multiple positive effects. Private sector primarily provides an adequate operation, then finance, know-how, new technology, commercial viability, competitiveness, placement to new markets as the part of major effects of partnership. Additional effects are investments of business partners, staff training, GDP growth, productivity, employment, export.

On the other hand the state appears as a guarantee that the public interest would be safeguarded, while granting the servitude right over land it reduces the total amount of investment and thus further attracts the foreign investment. Once the state has entered partnership with the private sector it will have the need to be flexible and to change so as to safeguard the common interest and to ensure a more favorable climate for new investment. Therefore there is a permanent harmonization of regulations to ensure the development of the energy sector and strengthen the overall economy, through attracting new investors.

4.4. Studies in developing

Investor has started next studies necessery for obtaining approval for exploitation:

— Study co-existence of coal exploitation and a potential regional sources of drinking water — "Studijom koegzistencije eksploatacije trebalo bi definisati tehnološke, kvalitativne i kvantitativne parametre uporednih mogućnosti eksploatacije svih navedenih resursa, sa mogućnostima i ograničenjima primene svake od navedenih metoda". Study of exploitation co-existence should define technological, qualitative and quantitative parameters of comparative possibilities of exploitation of these resources, with the capabilities and limitations of application of each of these methods.

— Study the current state of the environment (baseline condition) — Study is implemented in order to determine the current state of the environment ("zero" state) in the area of

implementation of planned projects and activities in the protected part of the coal basin Kovin, which is the prerequisite and basis for assessing the current state of environmental media, the establishment of a database on environment and planning mandatory protection measures and environmental monitoring.

— Feasibility study of coal exploitation — The task of this study is to examine the feasibility and economic feasibility of the process of coal and associated minerals from the fields A and B, especially from the point of considering the optimal development of mining operations, quality products that are obtained through appropriate processing, while protecting the environment.
— The feasibility study of building thermal power plant — The task of this study is to examine the economic feasibility and present the conceptual design of building thermal power plant, with basic technical parameters.
— Study recultivation of degraded land.
— Spatial plans for special purpose of the energy complex Kovin with strategic assessment of environmental impact — It is expected from the implementation of the study to be making the plan document as the planning basis for obtaining information about the location (Article 53 of the Law on Planning and Building "Official Gazette", No. 72/09 and 81/09) and Location permit for the implementation of planned projects within the Plan (Article 54 of the Law on Planning and Construction, "Official Gazette, No. 72/09 and 81/09).
— Study of environmental impact of exploitation and construction of thermal power plant.

5. Conclusions

Previous comprehensive geological surveys were established with the appropriate amount of coal quality that can be burn in a power plant and economically valorized.

Appropriate investment programs considered also the possibility of coal mining and performed the comparative analysis method of exploitation with the conclusion that the exploitation of larger scale is possible with underwater method.

Based on huge amount of data collected during geological, with 629 drilling samples, hydro-geological, mining and environmental assessment studies, IT IS POSSIBLE for coal extraction and groundwater abstraction TO COEXIST, provided that the impacts assessed are studied in detail during the course of development of design documents for the mine and the regional groundwater source in the Kovin-Dubovac area, and provided that appropriate measures are defined and implemented to allow for proper exploitation of these two resources.

The experience with technical excavation and transportation equipment of the experimental mine Kovin shows that a safe and environmental friendly mining is possible. The extracted coal quality is better than in a normal open-cast mining due to the better separation possibilities.

On the market are a high variety of different wet-dredgers. All modern extracting systems are computer controlled and their positions are controlled by satellite positioning systems. A strictly controlled mining in accordance to the official regulations is possible therefore.

Possibility to implement this project according to the principles of PPP.

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