

## **PROJECT: TPP »PLJEVLJA«II**

### **SUMMARY**

The region of South-East Europe copes with lack of generation capacities which, as assessed, will be increased in the forthcoming decade. The export-dependence is highly present, while increase in electricity consumption is expected. The development of HVDC cable between Italy and Montenegro brings further chances for investments in energy sector.

TPP Pljevlja II Project falls among such, potentially lucrative investments. It enables continuation of energy activities – electricity generation from Pljevlja-located coal performed in a more efficient and environmentally friendly manner, because limitation of the number of working hours and shut down of the existing unit I in TPP Pljevlja are expected to take place by 2018, i.e. 2024, respectively (environmental remediation of the facility in accordance with the requirements of the EU regulative for the remaining lifetime is not viable).

As part of activities related to this project, EPCG prepared technical documents – preliminary design and feasibility study for TPP Pljevlja II in 2012, as well as organised collection of bids submitted by bidders interested in construction of the new energy facility in 2013.

For the purpose of ensuring investment potentials for the project implementation, the interested bidders were offered to participate in the project as shareholders of the new company TPP-Coal Mine under favourable loan arrangements, while combining energy and financial interests.

The information provides basic technical and economic parameters of the new unit, summary of the past activities, overview of bids submitted by the interested bidders, assessment of the main project risks and proposal of the future activities.

The financial analysis of the project based on the best bids will be prepared and subsequently delivered as a specific addendum hereto (by the end of January 2014).

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## 1. INTRODUCTORY INFORMATION ABOUT TPP-I

TPP "Pljevlja"-I (TPP-I) was built as condensation thermal power plant of 210 MW, and it was commissioned at the end of the year 1982. Complex of TPP "Pljevlja" was designed as a system of 2 x 210MW. Construction of unit II was also planned by Decision on construction but it has not been constructed, although over 30% of the common structures and infrastructure was prepared during construction of unit I.

TPP-I has been in operation for over 30 years, it has almost 170,000 hours of operation. Its service life was designed to 25 years and it may be extended up to 40 years by rehabilitation of the main equipment. It means that the remaining service life of TPP-I is less than 10 years (determined by the remaining turbine resource which, according to manufacturer's recommendations, amounts to 220,000-240,000 hours of operation).

Thanks to reconstruction measures and modernization of main equipment during the last decade, the power plant reached high reliability indicators and indicators of security of generation, while the net efficiency indicators have also been increased, but not considerably, due to condition of technology. Net efficiency of the power plant is today around 32%, and it is possible to increase it at 34%.

Key problems in operation of TPP-I in the next period are the following:

- Big investments for ecological rehabilitation for the relatively short remaining service life are necessary (100-150M€):
  - o Construction of the new landfill for ashes and slag for disposal of combustion products (area of the exploited surface coal pit Šumani), with reconstruction of the transport system. Implementation of this project is necessary for continuation of operation of TPP-I,
  - o Resolving of problem with security (stabilization of the earth filled dam Maljevac-project in progress, reconstruction of the colling tower),
  - o resolving of ecological problems (reduction of emissions of SO<sub>2</sub>, NO<sub>x</sub>, treatment of waste waters, reclamation of landfill for ashes and slag Maljevac, removal of asbestos material from use).

Pursuant to the *Law on integrated prevention and environmental pollution control*, Official Gazette of the Republic of Montenegro 80/05, as well as to other relevant laws and regulations relating to environmental protection, EPCG is obliged to align the operation in the TPP "Pljevlja" with requirements set for issuing of so called Integrated permit.

According to the *Law on ratification of the Treaty between the European Community and the Republic of Montenegro establishing the Energy Community* (Athens Memorandum dated 2005), there is a requirement to implement the Directive 2001/80/EC of the European Parliament and Council dated 23<sup>rd</sup> October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants by 31<sup>st</sup> December, 2017.

According to the main conclusions reached on Ministerial Conference of the Energy Community of South East Europe, held in Belgrade on October 24<sup>th</sup>, 2013, with a particular focus on operation of the fossil fuel power plants (coal-fired power plants):

- regarding flue gasses emission thermal power plants can operate in the existing conditions by January 1<sup>st</sup>, 2018,
- mechanism for limitation of operation to total 20,000 hours will be applied in the period 2018-2024. Thermal power plants, having this operating regime, do not have to respect the limits in this period.

- Uncompetitiveness of production price, due to relatively high price of main energy fuel –coal,
- Relatively low efficiency.

In order to continue operation of thermal power complex in Pljevlja and meet electricity demand for a long time it is necessary to plan construction of the new unit, using the existing coal resources in Pljevlja basin, advantages of the existing location and opportunities provided by electricity market in the region, considering projection of generation/consumption ratio in the future.

## **2. ELECTRICITY BALANCE IN MONTENEGRO FOR THE PERIOD 2013-2016**

New energy generating facility has been built neither in Montenegro nor in the region for a long time, while the existing facilities are pretty old. Current economic crisis significantly affected the structure of electricity consumption so that households mainly represent main part of consumption while industrial customers cover less part of consumption.

Electricity balance for 2013 envisages that the total electricity consumption in Montenegro would amount to 3,620 GWh. Planned share of KAP in this consumption is 736 GWh (84 MW). On the other hand, the total generation was planned at a level of 3,100 GWh. The generation plan is made in accordance with the expected average rainfall, and this year it will be significantly exceeded. From the above it follows that in an average year the electric power system of Montenegro has a deficit of 150 GWh, or 4%.

On the other hand, implementation of TPP-II, along with joint generation of the both units, would result in considerable electricity surplus. Namely, it is estimated that in 2017, after implementation of the Project of TPP-II, the total electricity generation in Montenegro would amount 4,700 GWh (relative to 2013 there would be an increase resulting from generation of TPP-II of 1,400 GWh, and generation from wind generators of 200 GWh), while the consumption will be around 3,700 GWh.

The total electricity surplus will be 1,000 GWh, and it represents extremely good starting base for the period after installation of the submarine cable between Italy and Montenegro.

### 3. SWOT ANALYSIS OF PROJECT OF TPP-II

		<b>STRENGTHS</b>		<b>WEAKNESSES</b>	
<b>INTERNAL FACTORS</b>	1	Coal from Pljevlja and Maoče basin, as energy resource	1	Lack of resources for implementation of bigger investments	
	2	Optimal hydro/thermal energy ratio	2	Limited coal reserves	
	3	Balance of electricity generation-consumption	3	Coal - non-renewable resource	
	4	Development of transmission capacities of CGES and good connection with neighbouring transmission systems	4	Coal price and therefore relatively high generation price of kWh from TPP	
	5	Laying of submarine HVDC cable MNE-IT	5	Relatively high amortization of basic infrastructure (short remaining service life of TPP-I)	
	6	Alignment of law regulations related to energy sector and environmental protection with EU regulations	6	Negative impacts of the thermal power plant on environment	
	7	Organization of location of TPP-II	7	Relatively low efficiency of TPP-I	
	8	Constructed common facilities for TPP-I and TPP-II	8	Necessary land expropriation for opening of new coal deposits	
	9	Tradition and experience in electricity generation	9	Capacity of the future slag and ashes landfill of TPP	
	10	Human resources	10	Conditions of common structures of TPP-I and TPP-II	
	11		11	Insufficiently prepared joint form of organizing of RUP-EPCG/TPP	
<b>EXTERNAL FACTORS</b>	<b>OPPORTUNITIES</b>				
	1	Deficit and increase of electricity price in the region	1	Impossibility to financially secure the investments	
	2	Opening of the electricity market	2	Unfavourable financial conditions	
	3	Possibilities for electricity export	3	Construction of the other power plants in the region	
	4	Achieving of energy independence	4	Increasing competitive pressure	
	5	Additional optimization of hydro and thermal potentials (change of HPP status)	5	Ecology fees	
	6	Macroeconomic effects of TPP-II construction	6	Limitations/charges for CO2 emissions	
	7	Increase of efficiency and reduction of negative effects on environment (BAT, district heating)	7	Big investments in ecological rehabilitation of TPP-I	
	8	Favourable impact of development of electric power sector on MNE economy	8	Possibility to ban operation of TPP-I	
	9	Increase of stability of MNE electric power system and stability of electricity supply to customers	9	Exceeding the budget of TPP-II Project	
	10	Possibility for use of by-products in TPP Pljevlja (marl, ashes),	10	Longer period of TPP-II construction	
	11	Relatively short period of construction compared with other solutions	11	Making ecological requirements stricter in the future	
	12	Small specific investment for construction of TPP-II relative to the other solutions	12	Existing form of organizing RUP and EPCG/TPP	
	13	Potential for reduction of generation price of kWh through form of organizing of RUP-EPCG	13	Different interests of owners in RUP and EPCG	
	14	Ownership structure in RUP and EPCG	14	Local charges and taxes	
	15	Interest of potential partners for investments	15	Providing of limestone for the needs of TPP-II	
16	Engagement of local staff	16	Low efficiency of TPP-II than the required one		

The following conclusions/strategies may be defined based on the given swot matrix, as well as by comparison and analysis of internal and external factors:

<p><b>1. S-O strategy: using strengths of the system EPCG/TEP-RUP, in order to use effects of the opportunities which appeared in the surroundings</b></p>
<p>1.1. Exploit the existing coal reserves in Pljevlja basin through construction of more efficient energy capacity – thermal power plant at the existing location of TEP-I (S1,S7,S8 , O1,O2,O3).</p> <p>1.2. Increase electricity export using benefits of the project implementation in CGES and by connecting energy system of Montenegro with energy system of Italy through HVDC cable (S3, S4,S5,O3),</p> <p>1.3. Optimize total generation of EPCG through additional valorisation of HPP Piva potential (S3, O4, O5),</p> <p>1.4. Enable energy independency of Montenegro by implementation of the project TPP-II, as well as wide multiplicative effects on its economy (S7,S8,O6),</p> <p>1.5. Reachability of the best available techniques (BAT) and district heating of the town from TPP will enable environmental improvement in Pljevlja region (S6, O7).</p>
<p><b>2. W-O strategy : minimizing weaknesses and maximizing opportunities</b></p>
<p>2.1. Due to restricted coal reserves in Pljevlja basin, lower efficiency of TPP-I compared to TPP-II, short remaining lifetime of TPP-I and high investments in its ecological rehabilitation, TPP-I can be put into cold reserve (W2, W5,W7, O7).</p> <p>2.2. Investment potential for project implementation may be realized through participation of the interested bidder as a shareholder in the new company TEP-RUP which will operate within EPCG holding or through more favourable loan arrangements with combination of energy and financial interest (W1, O1,2,3),</p> <p>2.3. Reduction of the coal price, and consequently of the generation price of kWh from TPP-II, will be enabled by optimum organization of the system of RUP and TPP as a single company (W4, O1,2, 13),</p> <p>2.4. Prepare and analyse the possibility of opening slag and ashes landfill of TPP-II within exploitation area of OP Potrlica and after exploitation of the capacity in OP Šumani (W10,O7).</p> <p>2.5. Joint capacities of TPP-I and TPP-II (raw water pipeline, coal delivery, chemical water preparation, liquid fuel preparation, etc.) are to be exploited to the maximum in terms of construction due to their amortization and remaining lifetime, while technological equipment is to be reconstructed and modernized, if needed. (W11, O1,2,3).</p>
<p><b>3. S-T strategy : using available strengths and minimizing identified threats:</b></p>
<p>3.1. Find optimum financing model with interested partners (S1, T1),</p> <p>3.2. Ensure competitiveness of generation price from TPP through optimization of the project budget and exploitation costs of TPP-RUP,</p> <p>3.3. Contract with contractor of TPP-II is to provide protection mechanisms in order to avoid exceeding the project budget and deadlines,</p> <p>3.4. Compliance with the norms regarding emission of main pollutants (SO2, NOx, dust) is to be ensured by applying BAT techniques. Technical solutions are to be adjusted according to the decision about operation of TPP-I,</p> <p>3.5. Applying provisions of the Decision of the Ministerial Conference of Energy Community of SEE dated October 2013 related to operation of the existing thermal power plants,</p> <p>3.6. With reference to emission of CO2, the state strategy in ETS sector (Emission Trading Scheme) is to be defined during negotiations with EU.</p> <p>3.7. Common interest of EPCG and RUP owners, organizational form of the new company and its position in EPCG are to be defined,</p> <p>3.8. Study on supply of TPP-II with limestone based on domestic resources is to be developed.</p>
<p><b>4. W-T strategy: minimizing weaknesses and threats</b></p>
<p>4.1.If investment potential for TPP-II is not provided, strategy of TPP-I operation and necessary investments</p>

aimed at extending the lifetime up to economically acceptable possibilities is to be redefined,  
4.2.High investments in TPP-I (cooling tower, DeSOx, DeNOx) are to be desisted from, with favourable outcome of the activities S-T3.5.

#### **4. BASIC TECHNO-ECONOMICAL PARAMETERS OF TPP-II\_ EXTRACTS FROM THE FEASIBILITY STUDY**

For now, a basis for activities on realization of the project is a prepared technical documentation – preliminary design and feasibility study for TPP Pljevlja – II (TEP-II), prepared during 2012 by a Consortium of the Slovenian companies (ESOTECH and other).

Final evaluation of documentation in question is presented based on Designer's evaluation related to markets, costs, investments and other financial parameters.

Main elements of project of construction of TPP-II which are based on existing Basic Design and Feasibility Study are presented in the following text.

##### **4.1. Short description of investment:**

- Optimization of TPP Pljevlja (TEP) generating capacity, at the location of the existing Unit TEP-I, based on coal reserves in Pljevlja basin,
- Maximum utilization of the existing common infrastructure TPP-I and TPP II, implemented during construction of TPP-I.

##### **4.2. Investment targets:**

- continuation of electricity generation from thermo-power plants Pljevlja,
- securing of state's energy independence,
- formulation of assumptions for competitive participation of EPCG at the electricity market and increase of profitability of thermo –energetic complex of Pljevlja,
- optimal and efficient valorisation of coal reserves in pljevlja basin,
- solving of a key problem of Pljevlja valley environment in the heating season (a district heating project for Pljevlja city with TPP as a basic heating source ),
- direct or indirect effects to the regional economy, individual and social standard.

##### **4.3. The main technical parameters of the new unit**

###### **4.3.1. Coal reserves**

The raw material for new energy unit makes the coal of pljevlja basin. Total exploitation reserves in Pljevlja basin amount to 65.782.122 of tons. As per design engineer methodology, the Slovenian consortium, the balance reserves are being increased for 5% due to bedrock and inter-bed coals exploited as TPP-s energy – generating source. The Preliminary design of TPP-II operated with a 65Mt of exploitation reserves, without Mataruge deposit and with higher exploitation losses, thus providing security of further project calculations.

#### 4.3.2. Power of TPP-II

Based on coals' reserves and quality, assumed operation of the existing unit TPP-I and possible efficiency of the main equipment, the preliminary design envisages a condensing unit of TPP-II of **220MW** in power, with possible subtraction of heat for city heating.

While choosing the power of TPP-II, the starting point was the assumption that TPP-I will operate, until 2015, with 6500h of annual operation, and in parallel operation with TEP-II 6000h/year, while the TPP-II, in the first 25 years, would operate with 6500 equivalent annual hours (eh/year), and afterwards with 6000 eh/year. Thus a complete coal reserves in the Pljevlja basin would be used. Coalmine Pljevlja is of an attitude that parallel operation of TPP-I and TPP-II should not be questioned regarding CMPV capacities.

#### 4.3.3. Efficiency of the new unit

Recommendations of the European committee, stated in the document »Reference Document on Best Available Techniques for Large Combustion Plants«, July 2006, stated under the Chapter 4, item 4.5.5 – Thermal efficiency, are relevant for determination of efficiency degree of the new energy facilities, as shown in the table below (section):

Fuel	Technology of coal combustion	Net efficiency of the new Unit, %
Lignite	PC(DBB)	42-45
	FBC	>40
	PFBC	>42

For Unit based on technology of coal dust combustion (PC)<sup>1</sup> there is a problem of condition for net efficiency degree of >42%, which could be realized only by use of the so called ultra-critical (USC) steam parameters (pressure 250-275 bar, temperature of the fresh steam of >585°C). For those steam parameters a technical power minimum is higher than 370 MW, as per manufacturer data. That condition, practically, does not allow the installation of that boiler type for the unit of 220 MW. For such unit, as the practice shows, the achievable parameters of steam are 165-190 bar, 565/565°C enabling the realization of net efficiency degree at the level of up to 39%.

Combustion technologies in circular fluidized layer (CFB) need net efficiency degree of >40%, what is, together with the mentioned parameters and according to the designer's opinion, feasible and proved in practice in the referent facilities.

A designed degree of net efficiency with CFB technology is 40,82%.

#### 4.3.4. Ecological parameters

The best contemporary available techniques (BAT) are envisaged for the TPP-II, and they include all waste gasses cleaning measures<sup>2</sup>:

- emission of SO<sub>2</sub> : up to 150mg/nm<sup>3</sup> for PC combustion technology, respectively up to 200 mg/nm<sup>3</sup> for CFB combustion ,

<sup>1</sup> Technology used in TPP-I

<sup>2</sup> in accordance with the **DIRECTIVE 2010/75/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL** of 24 November 2010 on industrial emissions (integrated pollution prevention and control)



- emission of NOx : up to 200 mg/nm<sup>3</sup> for PC combustion technology, respectively up to 150 mg/nm<sup>3</sup> for CFB,
- dust emission: 10 mg/nm<sup>3</sup>.

Due to a higher energy efficiency, there will be less CO<sub>2</sub> emission in respect to the existing state. A heating station has been envisaged as well (maximum power of 75 MW<sub>th</sub>) for securing of thermal energy for district city heating, wherefore the pollution of air from individual fireboxes will be decreased.

#### 4.4. Investment level and structure

The necessary investments in the TPP-II have been evaluated to 366M€, respectively 1.538 M€/MW, with investment structure as shown at fig.3.1.

Per estimation, all civil works and important portion of activities implied under other investments could be implemented by engagement of local companies. It could amount to cca € 75 million in total.

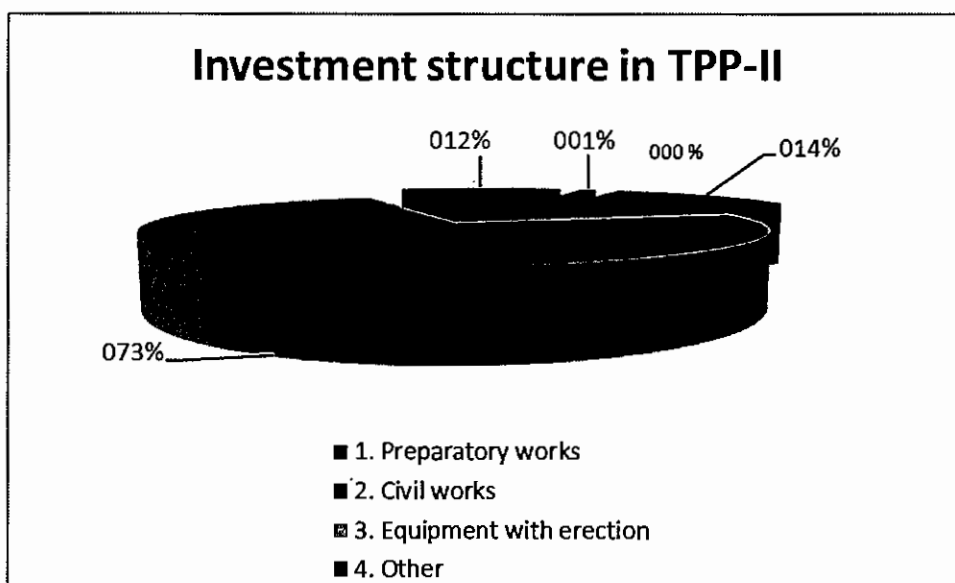


Fig.3.1 Investment structure

Table 3.2: Investments time schedule (in 000€)

	2013	2014	2015	2016	2017	2018	Total
Preparatory works		1.000					1.000
Civil works		5.759	23.993	14.542,6	5.997,2		50.292
Equipment with erection		34.223,6	87.684,1	105.719,7	26.413,2	16.166,4	270.207
Other	420	2.531,5	6.343,2	13.368,1	15.296,2	4.962,7	42.921
Working capital						2.189,0	2.189
<b>TOTAL</b>		<b>43.514,1</b>	<b>118.020,3</b>	<b>133.630,6</b>	<b>47.706,6</b>	<b>23.318,1</b>	<b>366.609</b>

#### 4.4.1. Structure and dynamics of financing sources

Table 3.3 Structure and dynamics of financing sources, in 000€

	2013	2014	2015	2016	2017	2018	Total
Own funds	420,0	43.514,1	10.303,5	15.328,6	17.034,5	23.318,1	109.918,8
Loans			107.716,8	118.302,0	30.672,1		256.690,9

<b>TOTAL</b>	<b>420,0</b>	<b>43.514,1</b>	<b>118.020,3</b>	<b>133.630,6</b>	<b>47.706,6</b>	<b>23.318,1</b>	<b>366.609,7</b>
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#### 4.5. Cost (generation costs), average cost and selling price of electricity

Table 3.4 shows average prices of electricity and thermal energy generation prices, as well as the average selling price within the operating life time of a project, where the coal costs have been calculated per price of 2,1€/GJ, and the assumed net efficiency of the Unit to 40,82%:

Table 3.4 Average generation prices of electricity and thermal energy

Coal price	€/GJ	2,1
Average electricity generation price	€/MWh	42,1
Average electricity selling price	€/MWh	65
Average thermal energy generation price	€/MWh	7,68

#### 4.6. Market evaluation of the Project

The market project evaluation is given in the table 3.5. for the following conditions:

- Economic lifetime of the project of 40 years,
- Discount rate 6,5%

Table 3.5. Market evaluation of the project

Parameter	u.p	Amount
Average electricity selling price	€/MWh	65,0
Average electricity generating costs	€/MWh	42,1
Period of investments return	god	14
Net present value, NPV (6,5% discount rate)	u 000€	128.875
Internal rent-ability rate, IRR	%	9,8
Relevant net present value, RNPV		0,38

#### CONCLUSION OF THE ECONOMIC ANALYSIS :

The project is economically acceptable. The return period of investments is shorter than the project's lifetime, net present value (NPV) is positive, Internal rent-ability rate (IRR) is higher than average price of financing source, a relative net present value (RNPV) is positive.

#### 4.7. Sensitivity analysis

Sensitivity analysis, shown in the tables 3.6, was performed for the following changes:

- Increase/decrease of the procurement coal price for 10 and 20%,
- Increase/decrease of selling electricity price for 5 and 10 EUR/MWh,
- Increase/decrease of the investments for 10 and 20%,

In the scope of the sensitivity analysis, the average generating electricity price has been calculated as well as internal rent ability rate depending on coal price (table 2.5).

Table 2.4. IRR in the sensitivity analysis

Sensitivity to coal price					
	-20%	-10%	2,1€/GJ	+10%	+20%
NPV (u 000 €)	173.939	151.407	128.875	106.363	83.812
IRR, %	10,8	10,3	9,8	9,2	8,7
Sensitivity to electricity selling price					
€/MWh	55	60	65	70	75
NPV (u 000 €)	-28.592	50.141	128.875	207.609	286.342
IRR, %	5,7	7,8	9,8	11,5	13,1
Sensitivity to investments					
	-20%	-10%	366M€	+10%	+20%
NPV (u 000 €)	193.365	161.120	128.875	96.630	64.385
IRR, %	12,2	10,9	9,8	8,8	7,9

Table 2.5 Generating electricity price and IRR in the function of the coal price

Coal price, €/GJ	Generation price, €/MWh	IRR
2,1	42,1	9,8
2,4	44,8	9,0
2,7	47,5	8,2
3,0	50,1	7,4

## 5. ADOPTED PARAMETERS OF NEW UNITS

The already mentioned *TPP2 Preliminary Design and Feasibility Study*, together with some changes/enclosures given below, represent the basis of the technical solution.

### 5.1. Technical requirements

#### 5.1.1. Coal reserves

There are cca **70Mt** of coal reserves in those deposits of this basin for which the Pljevlja Coal Mine holds concessions, and there are around **12 Mt** of reserves in three deposits (Otilovići , Mataruge i Bakrenjače) for which the Pljevlja Coal Mine does not hold concessions, what totals to **82 Mt**. If we add to the existing balance reserves an additional 5% of interbed topsoil or floor coal layers of poorer quality which will be uncovered during the coal exploitation what shall deteriorate coal quality, exploitation coal reserves of the Pljevlja basin together with other smaller deposits would amount to **86 Mt**.

Detailed information about coal mine in Annex 1.

#### 5.1.2. Parallel operation of both units

*TPP1 shall operate until the newly-built TPP2 starts operating, and then it shall be considered as a reserve and it shall operate depending on the electricity market price, limited by the number of operating hours, in line with decisions of the Ministerial Council of South-East European Energy Community (given in the introductory part).*

The key factor which limits both units operating in parallel is the quantity of coal and ecological problems in the existing unit. Having in mind that the new unit is of a much greater net energy efficiency than the

existing one, its operation shall surely prevail. The final decision about the TPP1 operation would be made until the year of 2022; investments would take place depending on such a decision, as well as an extension of its operations, or it would be prepared to be shut down by the year of 2025.

#### **5.1.3. Power of the TPP2**

The same as in case of joint operations, the coal quantity represents limiting factor when analysing the optimum power of the new unit.

After considering several different models, it is considered best to have the power of new units of 250MW

#### **5.1.4. Minimum net efficiency**

Minimum net efficiency required from the bidder is 38%. It can not be significantly higher than such a value due to relatively low power of the future TPP2.

#### **5.1.5. Combustion technology of the TPP2**

Both combustion technologies, CFB and PC, are acceptable.

CFB technology has been recommended by the Preliminary Design; upon analysing thermal power plants from Poland which are fired with the coal similar to that from Pljevlja, it has been concluded that this technology can be implemented in the new unit as well.

Furthermore, PC technology is also acceptable, having in mind an experience regarding application of the PC technology in the existing unit in Pljevlja.

#### **5.1.6. Joint facilities of TPP1 and TPP2**

One of the most important advantages of the TPP2 investment is the fact is that certain equipment and works for the TPP2 are already provided and carried out during construction of the TPP1. The most important of them are the following:

- Land owned by EPCG,
- Otilovići reservoir,
- Raw water pipeline from the Otilovići reservoir to the TPP,
- Chimney,
- Coal transportation,
- Liquid fuel transportation,
- Chemical water preparation,
- Workshops, warehouses, administrative building
- Roads, traffic arteries
- Connection to the Montenegro's energy system (switchyard 110/220/400kV, TPP2 – owned by CGES)

The present book value of the land and joint facilities stands at over €40 mil., what is more than 30% of the present value of the TPP1 facility.

Generally speaking, the existing joint facilities should be exploited to the maximum extent possible, particularly as far as the civil part is concerned, having in mind the remaining functional life of facilities and equipment as well as the need for joint facilities to function during the entire functional life of TPP2. With reference to the technology implementation in joint facilities, it has been required, wherever economically feasible, for an outdated technology to be replaced with the new one.

## 5.2. Commercial requirements

### 5.2.1. Project financing

The project financing terms have been defined roughly by financial and insurance institutions of the bidders:

- The bidder shall provide a loan in the amount of 75-85% of the total project finance, and the residual portion to be provided by EPCG,
- Security instruments – no guarantees of the State of Montenegro,
- Other loan terms,
- If bidders are interested to participate in the project in the capacity of a shareholder, it was necessary to state in which percentage and within which organization of the Pljevlja company,
- To reduce investment risks, there is also the option to merge Pljevlja Coal Mine and TPP Pljevlja.

### 5.2.2. Coal price

Six deposits which should meet technical and technological requirements to open and commence operation of the Pljevlja TPP2 were analysed in the economic part. Price of generation from these localities ranges from 13,66 €/t (Mataruge deposit) to 25,14 €/t (Potrlica deposit). Combination of exploitation and capacities with adequate homogenization results in coal price from 20,48 €/t to 23,92 €/t, or roughly 21 - 24 €/t.

*In order to determine the final price of electricity generated by TPP2, an average coal price of 2.1 EUR/GJ recorded over the exploitation period can be taken into consideration.*

## 6. OPEN ISSUES AND MAIN PROJECT RISKS

Implementation of the TPP Pljevlja II project is a challenging undertaking and it calls for an appropriate quality analysis of risks – financial, technical, operative, environmental, institutional, etc..

The following tables give account of open issues and main risks, including proposal for alleviation/elimination thereof.

Table No. 9.1. List of open issues

	Description	Jurisdiction	Priority (1-high, 2- medium, 3- low)
1	EPCG shareholders' agreement on this Project	A2A management and the Montenegrin Ministry of Economy	1
2	Method of project financing (own resources, co-ownership, commercial loans)	EPCG Board of Directors	1
3	Method of loan security (state or corporate guarantee)	Government of Montenegro, EPCG	1
4	Development of Preliminary Financial Analysis	EPCG	1
5	Discussion on proposals of DSP Pljevlja	Ministry of Sustainable Development – working group of the Ministry of Economy	1

6	Adoption of the final DSP Pljevlja	Ministry of Sustainable Development	1
7	Bid ranking	Working group of the Ministry of Economy	1
8	Amendments to technical documents – Preliminary Design of TPP - II	EPCG, Designer	2
9	Revision of technical documents – Preliminary Design of TPP - II	EPCG	2
10	Strategy for disposal of by-products from TPP	EPCG	1
11	Engagement of consultants	EPCG	1
12	EPCG-TPP-Coal Mine restructuring	Government of Montenegro, EPCG, Coal Mine	1/2

Table No. 9.2. Quality Risk Analysis for TPP-II Project

	Risk	Category	Likelihood (L- low, M-medium, H-high)	Severity factor (severity of consequence) (1- no; 5- high)	Risk alleviation measures (for severity factor >2)
1	Security of funds	Financial	H	5	Decision on method of financing
2	Search for a partner in the project	Financial / Institutional	H	2/3	Alternative solutions (no partner)
3	Restructuring of TPP-Coal Mine complex	Financial / Institutional	H	5	Quality preparation of restructuring
4	Proposals for DSP Pljevlja	Institutional / Technical/ Environmental	M/H	3/4	Discussion with project developer and adjustment of solution
5	DSP Pljevlja adoption procedure	Institutional	M/H	3/4	To accelerate adoption of DSP Pljevlja
6	Coal price	Economic	M/H	4/5	Optimisation of operating costs, reorganisation of Coal Mine - EPCG
7	Scope of coal quality which guarantees efficiency of the unit	Technical / Economic	H	3/4	Selection of combustion technology. Time schedule of coal exploitation, homogenisation.
8	Project coal	Technical / Economic	H	5	Boiler designer shall prepare and take part in implementation of coal sampling programme
9	Standards	Technical / Institutional	H	4/5	Harmonisation of standards in designing, equipment manufacturing and

					execution with the EU standards
10	The risk of exceeding allowed emission limits with CFB technology (need for installation of additional facilities for flue gas desulphurisation (FGD) and denitrification (DeNox).	Environmental/ Economic	M	5	Protection in the contract
11	The risk of being denied exemption from limits related to the environment and operation of Unit I	Institutional/ Environmental/ Economic	M	2	
12	Possible issues in relations with local government, NGOs, etc.	Institutional / Social	M	2	
13	Relatively high amortisation of the basic common infrastructure for TPP I and TPP II	Technical / Economic	M/H	5	To be taken into account during investment implementation
14	Need for land expropriation for the purpose of opening new coal deposits, landfill locations, etc	Social / Economic	H	4	To be considered in the project time schedule
15	Transport of heavy components of equipment to the site	Technical	H	3	To inspect the route and traffic conditions for the transport; to undertake necessary security measures
16	Exceeding deadlines for construction of TPP- II	Economic	H	5	Security within the contract. Project management. Interstate contract.
17	Charges for CO <sub>2</sub>	Environmental / Economic	M/H	4	To evaluate impact of this factor in the feasibility study.

## 7. RESTRUCTURING OF ENERGY COMPLEX IN PLJEVLJA

It has been assessed that association of the Coal Mine with EPCG or TPP is necessary for the purpose of ensuring resolving/alleviation of the future risks related to deliveries and price of coal. Also, preconditions for identification of the strategic partner who shall participate in ownership of the Project, which would be the best solution, are created.

More efficient implementation of TPP II Project requires structuring of EPCG (TPP I) and Coal Mine Pljevlja performed in the most appropriate manner with respect to their future operating. There are two possible approaches, whereof each understands association of EPCG (TPP I) and the Coal Mine Pljevlja.

1. Association of EPCG and Coal Mine, followed by spin-off of TPP and Coal Mine

2. Spin-off of TPP from EPCG, followed by association of TPP and the Coal Mine into a separate legal entity

EPCG shall decide which of the two models is better and start structuring of EPCG and the Coal Mine accordingly.

Minor shareholders of the Coal Mine (who own cca 30% stake) represent the biggest risk to the implementation of this activity. Namely, the process of restructuring should be agreed with them prior to initiation thereof. Otherwise, we may be required to repurchase the entire stake in Coal Mine belonging to minor shareholders who oppose the integration of the Coal Mine to EPCG. Since the repurchase shall be done at exchange market price recorded on the day of decision-making, the cost of integration may be significantly high (in 2010, A2A purchased shares of the Coal Mine at €9.5/share, which exceeded the nominal price by 100%. Should CM shares owned by minor shareholders be paid at the above price, the integration would require cca €13 million).

## **8. FRAMEWORK ACTIVITY PLAN UP UNTIL MAKING OF DECISION ON PROJECT IMPLEMENTATION**

The time schedule of the future project activities shall depend on selection of the method of financing and prospective project partner.

As for the pace of investment launch, the following three deadlines may be defined:

- a) Relatively quick project launch is possible if EPCG shareholders opt for financing with their own resources and funds obtained through commercial loan secured with state guarantee. **In that case, the project may be launched within six months.**
- b) Should EPCG shareholders opt for a loan from supplier of equipment, excluding a search for the project partner, the investment launch might take longer than above stated, and it would be less economical. **As assessed, the project may be launched within a year.**
- c) Should the EPCG shareholders decide to look for a partner within option b), the investment launch shall take even longer which may affect its overall effects adversely. **As assessed, the project may be launched within a year and a half.**

Taking into account all of the above aspects, the following activities in the process of project - related decision-making are suggested:

Table No. 11.1 Framework Activity Plan

	<b>Activity</b>	<b>Deadline</b>	<b>Executor</b>
<b>1</b>	<b>Defining chief technical conditions in the DSP Pljevlja</b>	Jan-feb 2015.	Ministry of Sustainable Development / Working group
<b>2</b>	<b>Selection of bidders</b>	Feb., 2015	Working group
<b>4</b>	<b>Decision about the project passed by EPCG Board of</b>	<b>March 2015.</b>	EPCG



	<b>Directors</b>		
5	<b>A decision about the project</b> (approval, method of financing)	<b>March 2015.</b>	Ministry of Economy and EPCG
6	<b>Elaboration of the detailed time schedule of the Project</b>	<b>March 2015.</b>	EPCG
7	<b>Contracting work</b>	<b>March-June 2015</b>	EPCG-Contractor

### **Appendix1:**

TECHNO-ECONOMIC ANALYSIS OF THERMOENERGETIC POTENTIAL FOR SUPPLYING THE THERMAL POWER PLANT "PLJEVLJA II" WITH COAL



Techno-economic analysis of the thermo-energetic potential for supplying the Thermal Power Plant  
Pljevlja with coal

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**COAL MINE STOCKHOLDERS COMPANY PLJEVLJA**  
**RUDNIK UGLJA A.D. PLJEVLJA**

**TECHNO-ECONOMIC ANALYSIS OF THERMOENERGETIC  
POTENTIAL FOR SUPPLYING THE  
THERMAL POWER PLANT "PLJEVLJA II" WITH COAL**



## INTRODUCTION

Techno-economic analysis of the thermo-energetic potential of the coal in the deposits of the Pljevlja basin includes:

- economic assessment of the price of the coal in the deposits
- reserves and quality of the coal in the deposits,
- mining-technical conditions of exploitation with the assessment of the investments and tables of consumption norms

Bases for the analysis:

- Preliminary design of the exploitation of coal in the Pljevlja coal basin;
- Studies of Classification, Categorisation and Estimate of the Coal Reserves and Quality in the deposits of the Pljevlja area;
- Technical part of the Study of the Concessions for the Coal Deposit;
- Draft Work Plan of the Coal Mine - Rudnik uglja A.D. Pljevlja, for the period 2013 – 2017;
- Other techno-economic documentation of the Rudnik uglja A.D Pljevlja.

The Statement of the Assessment is made on the basis of:

- detailed processing of geological data, presented in “Studies of Classification, Categorisation and Estimate of the Coal Reserves and Quality“, certified by the Ministry in charge of this area.
- the assessment of mining and geological, plus mining and technological conditions as well as the assessment of the technical structure of the investments and tables of consumption norms.
- the above stated represented the basis for the assessment of the price of coal production for each deposit individually.

The dynamics of exploitation can be defined only after defining the power of the potential Unit II of "Pljevlja" Thermal Power Plant and its construction times.

- The dynamics of exploitation shall be defined only after the determination of thermal power of Unit II of the "Pljevlja" Thermal Power Plant.

## I RESERVES AND QUALITY OF COAL

In the Pljevlja area there are several coal deposits, which can generally be divided into the areas of Pljevlja basin and Maoče basin.

Pljevlja basin, together with "Ljuće-Šumane" basin, comprises Potrlica coal deposits with the cement plant, "Kalušići", "Rabitlje", "Grevo" and "Komini", and then "Šumani I" and "Ljuće I", while other gravitating coal deposits are "Glisnica", "Bakrenjače", "Otilovići" and "Mataruge".

On the road Pljevlja - Bijelo Polje, at approximately 30 km, there is Maoče basin, which comes first in the reserves of coal.

Various sorts of lacustrine sediments from the Middle Miocene period also participate in the geological structure of the deposit, and those are generally dismembered into three packages: underlying package - underlying clays ( $^1M_2$ ), middle package - coal seam ( $^2M_2$ ), and upper package - overlying marls and marly limestones ( $^3M_2$ ).

The average calorific value of coal (DTE) in the deposits varies from **5 572 kJ/kg** in the Ljuće II deposit to **13 663 kJ/kg** in the Rabitlje deposit.

In the following table we can see the balance reserves of coal on the basis of the **certified Studies of Reserves and Quality of Coal** except for those for the Mataruge deposit, for which the Reserves Estimate, but not the Study, has been done.

The amounts of overburden which should be mined in order to exploit the coal are also given in the table, as well as the mean coefficient of the overburden, calorific value DTE, certification date of the Study with numbers of certificates and concession contracts.

The coal mine Rudnik uglja AD Pljevlja owns the concessions for research and exploitation of coal in the Pljevlja basin deposits and Glisnica deposit, which is 20 km from Pljevlja.

The coal reserves in Pljevlja basin and deposits for which the Mine has the concessions amount to **69 935 133 tons**, while in three deposits ("Otiloviće", "Mataruge" and "Bakrenjače) for which it does not have concessions, the reserves are **12 253 313 tons**, which make up a total of **82 188 446 tons**.

According to the previous research of coal and certified Elaborations (except for the Mataruge deposit), the coal reserves in the Pljevlja basin and gravitating smaller deposits, are **82 188 446 tons**.

For the needs of supplying the Thermal Power Plant for Unit I and Unit II of the **power 220-260 MW** in the next period there is the necessity of approximately **70 million tons** of coal whose quality is about 9 500 kJ/kg, so **it can undoubtedly be realised** with the present reserves of **82 188 446 tons**.

If we add 5% of the quantity of the interburden or underlying coals of poorer quality, which shall be dug during the coal exploitation, and by which the quality of the coal shall be reduced, to the existing balance reserves, then the **exploitation reserves** of the coal in the Pljevlja basin, together with other, smaller deposits would be **86 297 868 tons**.

Techno-economic analysis of the thermo-energetic potential for supplying the Thermal Power Plant Pljevlja with coal  
**REKAPITULACIJA BILANSNIH REZERVU UGLJA NA PODRUČJU PLJEVALJA (stanje 31.12.2012.)**

Stepen istraženosti rezervi uglja varira od ležišta do ležišta pa se stoga one izražavaju kao različite vrste kategorija rezervi:  
 A – dokazane rezerve uglja, B – istražene rezerve uglja, C1 – nedovoljno istražene rezerve uglja

Red. br.	Basen/ ležište	KATEGORIJA	Bilansne rezerve (t)	Učešće A+B (%)	OVJERA REZERVU	otkrivka (m <sup>3</sup> )	DTE (kJ/kg)	Sred. koefic. otkr.	Eksploat= Bilansne + 5 %	Koncesioni ugovor	Potvrda o rezervama (od minist.)
<b>I. Pljevaljski basen</b>											
1	Potrlica	A+B+C1	41213828.00	49.96	bilansne	160225752	10697	3.89	43274519.4		01-2098/3 28.01.2013.
2	Kalušići	A+B+C1	15047143.00	97.32	bilansne	46627374	7957	3.1	15799500.15	01-1025/1	0702-1708/2 24.09.2012.
3	Rabitlje	C1	5358361.00	0	bilansne	36014256	13663	6.72	5626279.05	2.1. 03. 2006.	
4	Grevo	C1	2281807.00	0	bilansne	11722118	12442	5.14	2395897.35		
5	Komini	C1	3016566.00	0	bilansne	5692624	11515	1.89	3167394.3		
	<b>UKUPNO I</b>		<b>66917705</b>			<b>260282124</b>		<b>3.9</b>	<b>70263590</b>		
<b>II. Ljuće-Šumanski</b>											
6	Šumani I	A+B+C1	200000	60	bilansne	230000	10418	1.15	210000	01-1025/1 21. 03. 2006.	01-1093/4 21.10.2009.
7	Ljuće II	B+C1	1056085	61.21	bilansne	500000	5572	0.47	1108889		01-545/5 02.11.2001.
8	Ljuće I	B+C1	60000	100	bilansne	100000	8600	1.67	63000		
	<b>UKUPNO II</b>		<b>1316085</b>			<b>830000</b>		<b>0.63</b>	<b>1381889</b>		
9	Glisnica	B	1701343	100	bilansne	4232019	9384	2.49	1786410	01-4147/1 01.06.2009.	0702-1710/3 15.10.2012.
	<b>RU</b>		<b>69935133</b>			<b>265344143</b>		<b>3.79</b>	<b>73431890</b>		
<b>III. OSTALA LEŽIŠTA</b>											
10	Otišlovići	B+C1	3421000	99.5	bilansne	11887300	10510	3.47	3592050		07-3889/1-92 16. 12. 1993
11	Bakrenjače	A+B+C1	1332313	73.64	bilansne	1151000	10296	0.86	1398929		01-679/1 23. 02. 1996.
12	Mataruge	C1	7500000	0	obračunate	15000000	8350	2.00	7875000		
	<b>UKUPNO III</b>		<b>12253313</b>			<b>28038300</b>			<b>12865978.65</b>		
	<b>UKUPNO I+II+III</b>		<b>82188446</b>			<b>293382443</b>		<b>3.57</b>	<b>86297868</b>		
13	Maoče	B+C1	109900000	82.98	bilansne	497500000	12504	4.53	115395000		07-3636/1-89 30. 01. 1989.
	<b>UKUPNO SVA LEŽIŠTA</b>		<b>192088446</b>			<b>790882443</b>		<b>4.12</b>	<b>201692868</b>		

Techno-economic analysis of the thermo-energetic potential for supplying the Thermal Power Plant Pljevlja with coal  
**RECAPITULATION OF THE BALANCE RESERVES OF COAL IN THE PLJEVLJA AREA (state on 31 December 2012)**

Degree of exploitation of the coal reserves varies from deposit to deposit, thus they are expressed as different sorts of reserve categories:

**A - proven reserves of coal**      **B - explored reserves of coal**      **C1 - not enough explored reserves of coal**

Ordinal No.	Basin/Deposit	Category	Balance reserves (1)	Participation A-B %	Reserve certification	Overburden (m3)	DTE (kj/kg)	Mean coeff. overburden	Exploit Balance + 5%	Concession contract	Reserve certificate (by Ministry)
<b>I Pljevlja basin</b>											
1	Potrica	A+B+C1	41213828.00	49.96%	balance	160225752	10697	3.89	43274519.4		01-2098/3
2	Kalušići	A+B+C1	15047143.00	97.32%	balance	46627374	7957	3.1	15799500.15	01-1025/1	28.01.2012.
3	Rabitlje	C1	5358361.00	0	balance	36014256	13663	6.72	5626279.05	21.03.2006.	0702-1708/2
4	Grevo	C1	2281807.00	0	balance	11722118	12442	5.14	2395897.35		24.09.2012.
5	Komini	C1	3016566.00	0	balance	5692624	11515	1.89	3167394.3		
<b>TOTAL I</b>			<b>66917705</b>			<b>260282124</b>		<b>3.9</b>	<b>70263590.25</b>		
<b>II Ljuče - Šumanski</b>											
6	Šumani I	A+B+C1	200000	60	balance	230000	10418	1.15	210000	01-1025/1	01-1093/4
7	Ljuče II	B+C1	1056085	61.21	balance	500000	5572	0.47	1108889	21.03.2006.	21.10.2009.
8	Ljuče I	B+C1	60000	100	balance	100000	8600	1.67	63000		01-545/5
<b>TOTAL II</b>			<b>1316085</b>			<b>830000</b>		<b>0.63</b>	<b>1381889</b>		02.11.2001.
9	Glisnica	B	1701343	100	balance	4232019	9384	2.49	1786410	01-4147/1	0702-1710/3
<b>RU</b>			<b>69935133</b>			<b>265344143</b>		<b>3.79</b>	<b>73431890</b>	01.06.2009.	15.10.2012.
<b>III OTHER DEPOSITS</b>											
10	Otišovići	B+C1	3421000	99.5	balance	11887300	10510	3.47	3592050		07-3889/1-92
11	Bakrenjače	A+B+C1	1332313	73.64	balance	1151000	10296	0.86	1398929		16.12.1993.
12	Mataruge	C1	7500000	0	calculated	15000000	8350	2.00	7875000		01-679/1
<b>TOTAL III</b>			<b>12253313</b>			<b>28038300</b>			<b>12865978.65</b>		23.02.1996.
<b>TOTAL I-II-III</b>			<b>82188446</b>			<b>293382443</b>		<b>3.57</b>	<b>86297868</b>		
13	Maoče	B+C1	109900000	82.98	balance	497500000	12504	4.53	115395000		07-3636/1-89
<b>TOTAL ALL DEPOSITS</b>			<b>192088446</b>			<b>790882443</b>		<b>4.12</b>	<b>201692868</b>		30.01.1989.

On the basis of the certified Studies, balance reserves and basic parameters for the quality of coal for each deposit are given in the following table

POTRLICA DEPOSIT	Category of reserves	RESERVES (t)	Zm (t/m <sup>3</sup> )	QUALITY INDICATORS			
				Wu (%)	P (%)	Su (%)	DTE (kJ/kg)
POTRLICA	A+B+C <sub>1</sub>	41 213 828	1.36	28.25	23.83	1.28	10697
KALUŠIĆI	A+B+C <sub>1</sub>	15 047 143	1.45	27.09	36.46	1.43	7957
RABITLJE	C <sub>1</sub>	5 358 361	1.36	34.00	10.93	-	13 663
KOMINI	C <sub>1</sub>	3 016 566	1.47	33.76	17.27	1.28	11515
GREVO	C <sub>1</sub>	2 281 807	1.36	29.33	20.92	1.43	12442
MATARUGE	C <sub>1</sub>	7500000	-	34.78	26.64	1.05	8350
GLISNICA	B	1701 343	1.37	36.45	21.30	2.40	9384
OTILOVIĆI	B+C <sub>1</sub>	3421000	1.32	37.42	13.70	0.80	10510
BAKRENJAČE	B+C <sub>1</sub>	1332313	1.31	39.99	15.14	0.96	10194
<b>TOTAL</b>		<b>80872609</b>	<b>1.38</b>	<b>30.01</b>	<b>24.63</b>	<b>1.29</b>	<b>10202</b>

The coal deposits “Rabitlje“, “Grevo“ and “Komini“ are not intended for exploitation, as they are not researched enough as well as the “Ljuće II“ deposit, due to the poor quality of coal. It does not mean that they will be more thoroughly explored and tested in further research or that exploitation reserves in these deposits will be defined on the basis of the elaborated and certified reserves.

The exploitation reserves (balance + 5%) and the quality of coal that will be used to supply the Thermal Power Plant Pljevlja I and II until the end of their operations are given in the following table.

DEPOSIT	Category of reserves	Zm (t/m <sup>3</sup> )	BALANCE RESERVES (t)	EXPLOITATION = BALANCE +5% (t)	Wu (%)	P (%)	Su (%)	DTE (kJ/kg)
POTRLICA	A+B+C <sub>1</sub>	1.36	41213828	43274519	28.25	23.83	1.28	10188
KALUŠIĆI	A+B+C <sub>1</sub>	1.45	15047143	15799500	27.09	36.46	1.43	7578
MATARUGE	C <sub>1</sub>	-	7500000	7875000	34.78	26.64	1.05	7891
GLISNICA	B	1.37	1701343	1786410	36.45	21.3	2.4	8937
OTILOVIĆI	B+C <sub>1</sub>	1.32	3421248	3592310	37.42	13.7	0.8	10010
BAKRENJAČE	B+C <sub>1</sub>	1.31	1332313	1398929	39.99	15.14	0.96	9806
<b>TOTAL</b>		<b>1.31</b>	<b>70215875</b>	<b>73726669</b>	<b>29.57</b>	<b>26.12</b>	<b>1.29</b>	<b>9342</b>

If we conditionally add the balance reserves in the coal deposits “Rabitlje“, “Grevo“ and “Komini“, which amount to **10 656 734 t**, to the calculated exploitation reserves, total exploitation reserves are **84 383 403 t**.

## II EXPLOITATION RESERVES AND THERMOENERGETIC POTENTIAL

$$E_{p1} = DTE \text{ (MJ/kg)} \times P \times 10^9 \text{ (kg)}$$

$$E_{p1} = 9.342 \text{ (MJ/kg)} \times 84 \times 10^9 \text{ (kg)} = 784.728 \times 10^9 \text{ (MJ)}$$

$$\text{Kako je MJ} = 1/3,6 \text{ kWh} = 0,2778 \text{ kWh}$$

$$E_{p1} = 784.728 \times 10^9 \times 0,2778 = 218 \text{ TWh}$$

With the efficiency of 0.39 the production of electricity is 85 TWh



## BRIEF ANALYSIS OF THERMOENERGETIC POTENTIAL

The degree of exploration of coal in Pljevlja municipality is very high, while the data reliability for the coal reserves allows the definition of thermoenergetic potentials.

It is indicated by the fact that the stated data on quantity and quality of the coal are defined through the categories:

*A+B*.....83%  
*C*.....17%

The balance and exploitation reserves are defined on the basis of geological reserves and they amount:

➤ *balance* .....82188 446 t  
➤ *exploitation* ..... 86 297868 t  
➤ *exploitation reserves quality* ..... 9 342 kJ/kg

Mining-geological and mining-technological conditions of the exploitation in the deposits condition the application of discontinuous and combined system of mining coal and overburden.

The price of the coal in the function is conditioned by mining and geology and varies according to the deposits, ranging from 13.66 €/t to 25.14 €/t respectively 1.73 €/GJ do 2.93 €/GJ.

**For the needs of potential construction of Unit II of the “Pljevlja“ Thermal Power Plant, the reserves and quality of the coal in the Pljevlja coal basins are not disputed.**

Defining the terms of construction of Unit II, the dynamics of the production development should be created, after which the order of exploitation and therefore the average price of the coal shall be defined.

With the construction of Unit II of the “Pljevlja“ Thermal Power Plant, better opportunities for producing thermal energy and district heating system of the town of Pljevlja would be created. The expected effects of the district heating system are:

- ❖ reduced amounts of burned coal in town in the furnaces with low utilization which operate without any devices for protecting the environment from the pollution.
- ❖ increased quality of heating in comparison with the existing one
- ❖ techno-economic effects are important at both the Power Plant level and EES level
- ❖ reduced level of harmful substances and significantly improved quality of the environment.

Building Unit II of the “Pljevlja“ Thermal Power Plant fits into the correlated strategic goals of the world’s energy development in 21<sup>st</sup> century in order to achieve the sustainable development.

**Accessibility** – energy is accessible at affordable prices which allow the production of energy, its transformation and distribution, and which provide the basis for further development and maintenance of energy systems.

**Availability** – allowing continuous supply of energy for a long time.

**Acceptability** – achieving the compliance of social goals with environmental goals, which has to be satisfied by both traditional and modern energy sources.

**The accessibility of energy, its availability and acceptability** represent concepts permeating each others at both local and global levels, and only with simultaneous meeting all the three requests the energy sources are capable of providing the sustainable development concept. Here the coordination of **4E (Energy, Ecology, Economy and Efficiency)** get the essential importance .

When it comes to the strategic development of production of coal and coal electricity: the suggested development of the production comes within the scopes defined by the energy development which serves the purpose of significant improvement of the status quo

**Energy** – The structure of electricity production in Montenegro is favourable. The deficit is expressed, the consumption is high and the energy crisis is constantly present. Building the second unit of the Thermal Power Plant "Pljevlja", the structure of the production would be acceptable, and all other elements significantly milder or overcome.

**Ecology** – The situation in Pljevlja is worrying, but it could be significantly improved by producing thermal energy for the needs of the district heating system in the town and producing industrial steam for other consumers. The district heating system in the town would make microclimate conditions much more favourable.

**Economy** – Greater production of coal and coal electricity shall significantly improve the economy of operations of both coal producers and the Energy Sector in Montenegro.

**Efficiency** – Own energetic potentials shall represent the basic source for electricity production, by which the export dependence is exchanged or eliminated and research and development are speeded.

**This all indicates the following:**

- affordable prices of coal,
- undisputed reserves and quality,
- production can be organised within sustainable development.

The bases provide making strategic decisions.

In making the strategic decisions the question "WHAT IF" must be answered.

What if there is no continuity in the production of coal and coal electricity in Pljevlja and Montenegro.

**There is no sustainability of Pljevlja and Pljevlja municipality and there is also no reliable and stable electric-energetic system in Montenegro.**

There is no need to even discuss the consequences.

Since the answer to the question "WHAT IF" has no alternative, we must find the answers to the questions "HOW MUCH" and "HOW" .

"HOW MUCH" requires defining the capacities in the production of coal and coal electricity - long-term.

"HOW" - in the given timeframes building Unit II of the "Pljevlja" Power Plant and developing the necessary capacities in the coal production.

Beside the proceeded deposits in the Pljevlja coal basin, long-term providing the development of thermoenergetics in Montenegro can reliably be based on the defined balance reserves in Maoce coal basin, which are 109 900 000 t with the quality of 12,504 GJ/kg.

GENERAL MAP OF THE COAL DEPOSITS IN THE PLJEVLJA AREA WITH THE COAL  
MINE AND THERMAL POWER PLANT PLJEVLJA FACILITIES

Scale = 1:200 000

LEGEND

PLJEVLJA BASIN

- 1 POTRLICA (UNDER EXPLOITATION)
- 2 DURUTOVICI
- 3 KALUSICI
- 4 GREVO
- 5 KOMINI
- 6 RABITLJE

POTENTIAL DEPOSITS

- 14 TJESANJ
- 15 BUSNJE
- 16 GOTOVUSA
- 17 GLISNICA
- 18 BOLJANICI
- 19 RADJEVICI
- 20 VOJTINA

LJUČE/SUMANI DEPOSIT

- 7 LJUČE (EXPLOITATION COMPLETED)
- 8 SUMANI I (EXPLOITATION COMPLETED)
- 9 SUMANI II (UNDER EXPLOITATION)

10 BAKRENJACE DEPOSIT

- 11 OTILOVICI DEPOSIT
- 12 MATARUGE DEPOSIT
- 13 MAOCE DEPOSIT

21 PLJEVLJA THERMAL POWER PLANT

- 22 PALESKI POTOK SLAG LANDFILL
- 23 POTENTIAL LANDFILL BABICA POTOK
- 24 POTENTIAL LANDFILL P.K. BOROVIČA LJUČE
- 25 DAM (OTILOVICI ACCUMULATION)
- 26 ACCESS ROAD TO THE DAM
- 27 PIPELINE
- 28 POTENTIAL LANDFILL CRČENI POTOK

MAP OF THE COAL DEPOSITS IN THE PLJEVLJA COAL BASIN  
FOR WHICH THE COAL MINE RUDNIK UGLJA A.D.HAS GOT THE CONCESSION  
Scale: 1:10 000

NAME OF DEPOSIT            AREA (ha)            BALANCE RESERVES

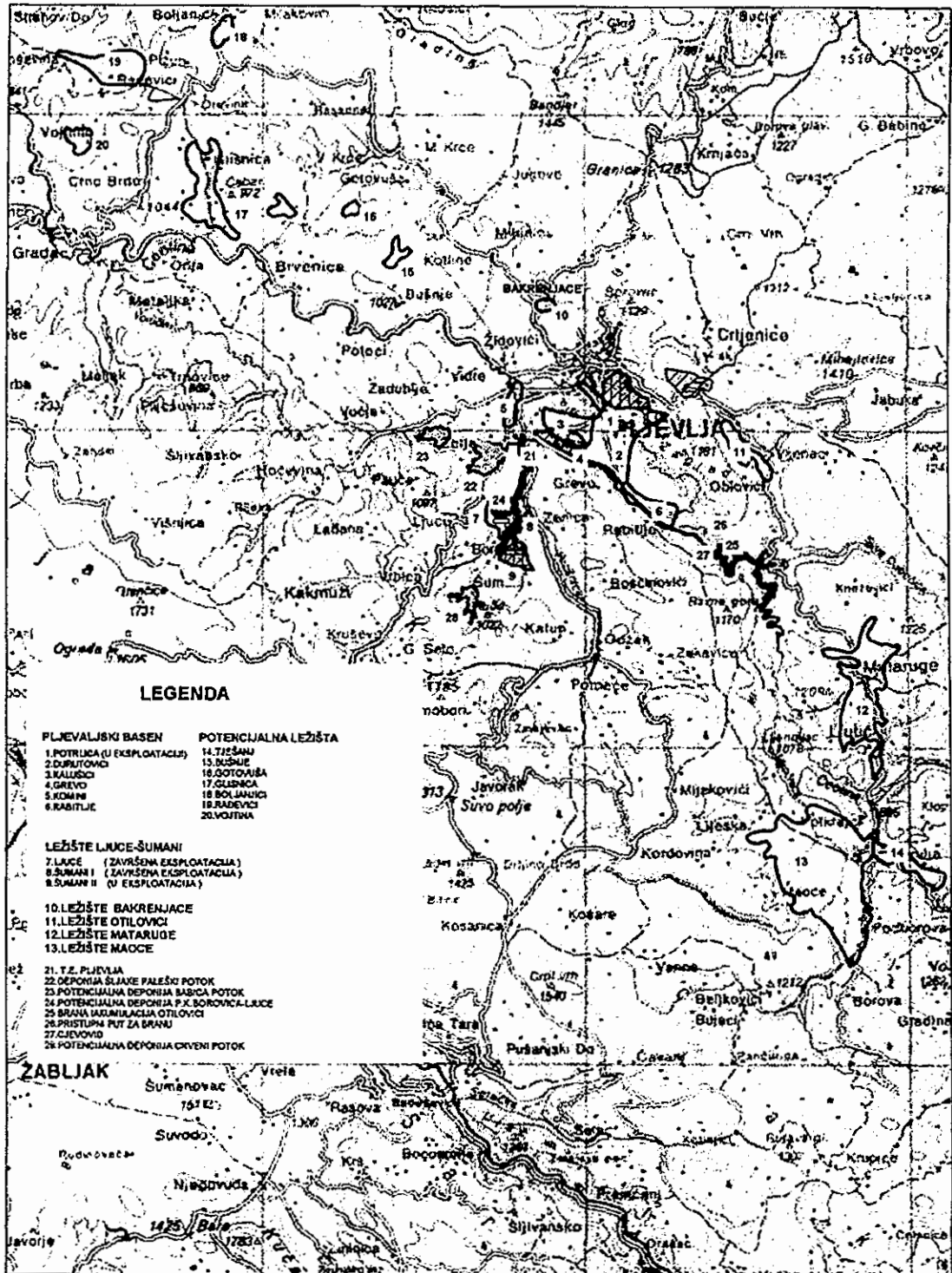
COORDINATES OF THE CONCESSION BOUNDARIES

Point No.   y   x   side   side length

LEGEND  
CONCESSION AREA BOUNDARIES  
“POTRLICA“ DEPOSIT GEOLOGICAL BOUNDARY  
“KALUSICI“ DEPOSIT GEOLOGICAL BOUNDARY  
“GREVO“ DEPOSIT GEOLOGICAL BOUNDARY  
“RABITLJE“ DEPOSIT GEOLOGICAL BOUNDARY  
“KOMINI“ DEPOSIT GEOLOGICAL BOUNDARY

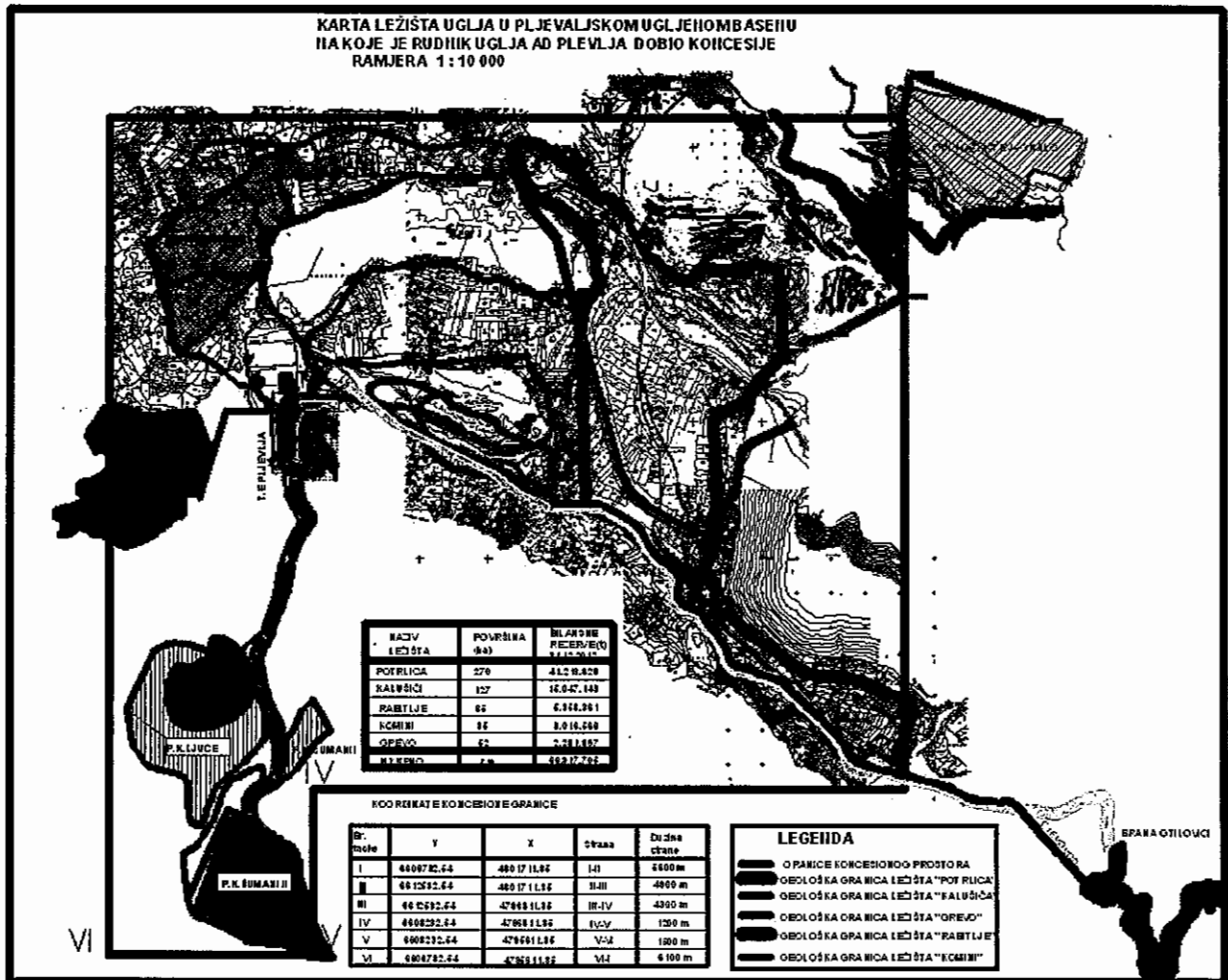
Techno-economic analysis of the thermo-energetic potential for supplying the Thermal Power Plant Pljevlja with coal

PREGLEDNA KARTA LEŽIŠTA UGLJA PLJEVALJSKOG  
PODRUČJASA OBJEKTIMA RUDNIKA I T.E. PLJEVLJA  
R=1:200000



Prilog br. 1.0

Techno-economic analysis of the thermo-energetic potential for supplying the Thermal Power Plant Pljevlja with coal



### III ECONOMIC PART

#### 3.1. "Potrlica" deposit

1. Balance (certified) reserves.....41.213.828 t
2. Exploitation reserves..... 43.274.519 t
3. Amount of overburden.....160.225.842 m<sup>3</sup>čm
4. Mean coefficient of overburden..... 4,35 m<sup>3</sup>čm / t
5. DTE (kJ/kg)..... 9.724 kJ/kg
6. Deposit area .....350 ha
7. Total investments(for next 5 years).....64.072.700 euros
  - 7.1. Expropriation.....28.200.000 euros
8. Expropriation period..... 29 years
9. Annual production..... 1.500.000 tons
10. Number of employees..... 733 workers

#### Cost price calculation

R/B	CALCULATION ELEMENT	TOTAL FOR 1.500.000,00 tons of coal per year	Euros per ton
1.	Material expenses	8.880.000,00	5,92
2.	Depreciation	3.853.168,00	2,57
3.	Capital maintenance	1.204.115,00	0,80
4.	Insurance premiums	722.469,00	0,48
5.	Labour costs	12.296.644,00	8,19
6.	Interests	1.429.682,10	0,95
7.	Loan repayments	6.407.270,00	4,27
8.	Concession fee costs	2.370.000,00	1,58
9.	Environmental protection costs	200.000,00	0,13
10.	Other costs	373.383,50	0,25
	<b>TOTAL:</b>	<b>37.711.756,10</b>	<b>25,14</b>

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### 3.2. "Kalušići" deposit

1. Balance (certified) reserves..... 15.047.143 t
2. Exploitation reserves..... 15.799.500 t
3. Amount of overburden..... 46.627.374 m<sup>3</sup>čm
4. Mean coefficient of overburden..... 3,31 m<sup>3</sup>čm / t
5. DTE (kJ/kg)..... 7.233 kJ/kg
6. Deposit area .....127 ha
7. Total investments(for next 5 years)..... 30.511.175 euros
  - 7.1. Expropriation.....28.200.000 euros
8. Expropriation period..... 32 years
9. Annual production..... 500.000 tons
10. Number of employees..... 102 workers

### Cost price calculation

R/B	CALCULATION ELEMENT	TOTAL FOR 500.000,00 tons of coal per year	Euros per ton
1.	Material expenses	1.950.000,00	3,90
2.	Depreciation	1.537.280,00	3,08
3.	Capital maintenance	480.400,00	0,96
4.	Insurance premiums	288.240,00	0,57
5.	Labour costs	1.711.152,00	3,43
6.	Interests	680.809,16	1,36
7.	Loan repayments	3.731.926,66	7,46
8.	Concession fee costs	401.750,00	0,80
9.	Environmental protection costs	212.500,00	0,42
10.	Other costs	109.940,58	0,22
	<b>T O T A L:</b>	<b>11.103.998,40</b>	<b>22,20</b>



### 3.3. "Otilovići" deposit

1. Balance (certified) reserves..... 3.421.000 t
2. Exploitation reserves..... 3.592.310 t
3. Amount of overburden..... 11.887.300 m<sup>3</sup>čm
4. Mean coefficient of overburden..... 3.23 m<sup>3</sup>čm / t
5. DTE (kJ/kg)..... 9.554 kJ/kg
6. Deposit area ..... 53 ha
7. Total investments(for next 5 years)..... 12.287.868 euros
  - 7.1. Expropriation..... 1.980.000 euros
8. Expropriation period..... 12 years
9. Annual production..... 300.000 tons
10. Number of employees..... 72 workers

#### Cost price calculation

R/B	CALCULATION ELEMENT	TOTAL FOR 300.000,00 tons of coal per year	Euros per ton
1.	Material expenses	2.085.987,94	6,95
2.	Depreciation	724.406,70	2,42
3.	Capital maintenance	229.958,70	0,76
4.	Insurance premiums	148.903,40	0,49
5.	Labour costs	1.207.872,00	4,04
6.	Interests	274.184,55	0,91
7.	Loan repayments	1.228.786,80	4,09
8.	Concession fee costs	289.500,00	0,96
9.	Environmental protection costs	65.000,00	0,22
10.	Other costs	62.546,00	0,20
	<b>TOTAL:</b>	<b>6.317.146,09</b>	<b>21,05</b>

### 3.4. "Bakrenjače" deposit

1. Balance (certified) reserves..... 1.332.313 t
2. Exploitation reserves..... 1.398.929 t
3. Amount of overburden..... 1.151.000 m<sup>3</sup>čm
4. Mean coefficient of overburden..... 0,82 m<sup>3</sup>čm / t
5. DTE (kJ/kg)..... 9.360 kJ/kg
6. Deposit area ..... 11 ha
7. Total investments(for next 5 years)..... 9.815.550 euros
  - 7.1. Expropriation..... 5.715.000 euros
8. Expropriation period..... 5 years
9. Annual production..... 300.000 tons
10. Number of employees..... 37 workers

### Cost price calculation

R/B	CALCULATION ELEMENT	TOTAL FOR 300.000,00 tons of coal per year	Euros per ton
1.	Material expenses	1.160.885,68	3,89
2.	Depreciation	286.616,50	0,95
3.	Capital maintenance	90.771,30	0,30
4.	Insurance premiums	58.287,00	0,19
5.	Labour costs	620.712,00	2,07
6.	Interests	438.037,29	1,46
7.	Loan repayments	1.963.110,00	6,54
8.	Concession fee costs	285.450,00	0,95
9.	Environmental protection costs	65.000,00	0,22
10.	Other costs	49.688,69	0,16
	<b>T O T A L:</b>	<b>5.018.558,46</b>	<b>16,72</b>

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### 3.5. "Mataruge" deposit

1. Balance (certified) reserves..... 7.500.000 t
2. Exploitation reserves..... 7.875.000 t
3. Amount of overburden..... 15.000.000 m<sup>3</sup>čm
4. Mean coefficient of overburden..... 1,81 m<sup>3</sup>čm / t
5. DTE (kJ/kg)..... 7.891 kJ/kg
6. Deposit area ..... 127 ha
7. Total investments(for next 5 years)..... 13.547.475 euros
  - 7.1. Expropriation..... 2.926.500 euros
8. Expropriation period..... 16 years
9. Annual production..... 500.000 tons
10. Number of employees..... 84 workers

#### Cost price calculation

R/B	CALCULATION ELEMENT	TOTAL FOR 500.000,00 tons of coal per year	Euros per ton
1.	Material expenses	2.156.377,61	4,31
2.	Depreciation	686.534,70	1,37
3.	Capital maintenance	202.861,00	0,41
4.	Insurance premiums	148.694,10	0,31
5.	Labour costs	1.409.184,00	2,81
6.	Interests	302.290,07	0,60
7.	Loan repayments	1.354.747,5	2,71
8.	Concession fee costs	427.750,00	0,85
9.	Environmental protection costs	75.400,00	0,15
10.	Other costs	67.638,39	0,14
	<b>TOTAL:</b>	<b>6.831.477,37</b>	<b>13,66</b>

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### 3.6. "Glisnica" deposit

1. Balance (certified) reserves..... 1.701.343 t
2. Exploitation reserves..... 1.786.410 t
3. Amount of overburden..... 4.232.019 m<sup>3</sup>čm
4. Mean coefficient of overburden..... 2,38 m<sup>3</sup>čm / t
5. DTE (kJ/kg)..... 8.530 kJ/kg
6. Deposit area ..... 55 ha
7. Total investments(for next 5 years)..... 7.764.995 euros
  - 7.1. Expropriation..... 1.985.000 euros
8. Expropriation period..... 6 years
9. Annual production..... 300.000 tons
10. Number of employees..... 58 workers

#### Cost price calculation

R/B	CALCULATION ELEMENT	TOTAL FOR 300.000,00 tons of coal per year	Euros per ton
1.	Material expenses	1.710.826,58	5,70
2.	Depreciation	448.569,75	1,49
3.	Capital maintenance	140.299,90	0,47
4.	Insurance premiums	84.885,95	0,28
5.	Labour costs	966.744,00	3,23
6.	Interests	346.527,44	1,15
7.	Loan repayments	1.552.999,00	5,17
8.	Concession fee costs	268.125,00	0,89
9.	Environmental protection costs	82.000,00	0,28
10.	Other costs	56.009,77	0,19
	<b>T O T A L:</b>	<b>5.656.987,39</b>	<b>18,85</b>

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**RECAPITULATION**

**IN EUROS**

R/B	DEPOSIT	POTRLICA	KALUŠIĆI	OTILOVIĆI	BAKRENJAČE	MATARUGE	GLJISNICA
I	EKSOLP.RESERVES (T)	43.274.519	15.799.500	3.592.050	1.398.929	7.875.000	1.786.410
II	DTE ( kJ/kg)	10.188	7.578	10.010	9.806	7.891	8.937
III	SELLING PRICE OF COAL ACCORDING TO QUALITY	28,37	21,10	27,87	27,31	21,97	24,89
IV	REVENUES FROM SALES OF COAL	1.227.698.104	333.369.450	100.110.433	38.204.751	173.013.750	44.463.744
	<b>PRICE CALCULATION</b>						
1.	Material expenses	5,92	3,90	6,95	3,89	4,31	5,70
2.	Depreciation	2,57	3,08	2,42	0,95	1,37	1,49
3.	Capital maintenance	0,80	0,96	0,76	0,30	0,41	0,47
4.	Insurance premiums	0,48	0,57	0,49	0,19	0,31	0,28
5.	Labour costs	8,19	3,43	4,04	2,07	2,81	3,23
6.	Interests	0,95	1,36	0,91	1,46	0,60	1,15
7.	Loan repayments	4,27	7,46	4,09	6,54	2,71	5,17
8.	Concession fee costs	1,58	0,80	0,96	0,95	0,85	0,89
9.	Environmental protection costs	0,13	0,42	0,22	0,22	0,15	0,28
10.	Other costs	0,25	0,22	0,20	0,16	0,14	0,19
	<b>MANUFACTURING PRICE OF COAL</b>	<b>25,14</b>	<b>22,20</b>	<b>21,05</b>	<b>16,72</b>	<b>13,66</b>	<b>18,85</b>
	<b>Euro/ton</b>						
	<b>GROSS PROFITS</b>	3,23	- 1,10	6,82	10,59	8,31	6,04
	<b>TAX ON PROFITS</b>	0,29	-	0,61	0,95	0,75	0,54
	<b>NET PROFITS</b>	2,94	-	6,21	9,64	7,56	5,50
	<b>TOTAL INVESTMENTS</b>	64.072.700	30.511.175	12.287.868	9.815.550	20.375.975	7.764.995
	<b>SOLE EXPROPRIATION</b>	6.193.300	10.126.500	1.980.000	5.715.000	9.755.000	1.985.000
	<b>MANU. PRICE OF COAL</b>						
	<b>Euro/GJ</b>	2,47	2,93	2,10	1,70	1,73	2,11

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## CONCLUSION

In the economic section, we observed the six deposits that are supposed to meet technical and technological conditions for opening and work of the second Unit of the Thermal Power Plant Pljevlja.

From the previous calculations one could conclude that the production costs from these sites range from 13.66 €/t for "Mataruge" deposit to 25.14 €/t for "Potrlica" deposit. Expressed in thermal units - from 1.73 euro/GJ to 2.58 euro/GJ.

A large share of costs of capital is emphasised in the pricing structure, because the loan terms of the production in these processes of transition still get out of the frame of economic logic which prevails in the markets of the countries with economic regulation. One of the outcoming anomalies is that in most cases the material costs outcome the costs of capital. All this should be taken into consideration when producer prices are assessed.

The range of the manufacturing prices allows combining exploitation in deposits in order to get the most optimal production according to all parameters, primarily to quality and price.

The economic evaluation is done on the basis of assessment of the coal and overburden exploitation costs as well as of the investments. Not any significant price fluctuations should be expected, even after the comprehensive understanding of all the conditions that are to be defined during the elaboration of the necessary techno-economic documents.

**The elaboration in this material also includes the "Mataruge", "Otiloviće" and "Bakrenjače" deposits for which the Coal Mine does not have concessions.**

**In the process of building the second unit of the Thermal Power Plant Pljevlja, additional research and exploitation in the "Mataruge", "Otiloviće" and "Bakrenjače" deposits would be provided if the Coal Mine got the concessions for the mentioned deposits.**

**By combining the exploitation from specific sites and their adequate homogenisation, we determine the price of coal ranging from 20.48€/t to 23.92€/t, respectively rounding them from 21€/t to 24€/t.**

..... (End of translation) .....

I, the undersigned sworn-in court interpreter, certify hereby that this translation into English is fully true to the original text written in the Serbian language.