

# 7<sup>th</sup> Balkan Mining Congress

“BALKAN MINING FOR  
THE FRIENDSHIP AND PROGRESS”

Book of Proceedings  
I



11-13 October 2017, Prijedor

Year 7, No.7 (2017)

ISSN: 2566-3313

Proceedings  
**BALKANMINE**

BALKANMINE 2017  
**7<sup>th</sup> Balkan Mining Congress**

BOOK I

**Prijedor, October 11-13, 2017.**

CIP - Каталогизacija y publikaciji  
Народна и универзитетска библиотека  
Републике Српске, Бања Лука

622:55(497)(082)

BALKAN Mining Congress (7 ; 2017 ; Prijedor)  
Balkanmine : Proceedings. Book 1 / 7th Balkan Mining Congress,  
Prijedor, October 11-13, 2017. ; [Editors Slobodan Vujić, Vladimir  
Malbašić]. - Prijedor : University of Banja Luka, Faculty of Mining ;  
Belgrade : Mining Institute, 2017 (Banja Luka : Mako Print). - 382 str. :  
ilustr. ; 30 cm

Kor. nasl.: Balkan Mining for the Friendship and Progress. - Na nasl.  
str.: Year 7, No.7 (2017) ISSN: 2566-3313. - Tiraž 200. - Bibliografija uz  
svaki rad. - Registar. - Abstracts.

ISBN 978-99955-681-7-7 (Faculty of Mining)

COBISS.RS-ID 6803736

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UNIVERSITY OF  
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FACULTY OF MINING  
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ACADEMY OF SCIENCE  
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UNION OF ENGINEERS  
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## Proceedings Publishers:

University of Banja Luka Faculty of Mining Prijedor  
Save Kovačevića bb, 79101 Prijedor, RS/BiH

Mining Institute Belgrade Ltd  
Batajnički put 2, 11080 Beograd, Zemun, Serbia

## Editors:

Academician Slobodan Vujić  
Prof. dr Vladimir Malbašić

## Technical Editor:

Prof. dr Lazar Stojanović

## Design, text capture and processing by:

Lazar Stojanović  
Dražana Tošić  
Miodrag Čelebić

## Printed by:

MAKO PRINT d.o.o. Banja Luka

**Issued:** October 2017

**Circulation:** 200

[www.balkanmine2017.com](http://www.balkanmine2017.com)  
[www.rf.unibl.org/](http://www.rf.unibl.org/)

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## MODEL OF MULTICRITERIUM RANGE OF COAL DEPOSITS SUITABLE FOR UNDERGROUND GASIFICATION

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### ABSTRACT

The underground gasification of coal is a modern "clean" technology for obtaining quality energy - SYNGAS and has not been explored in these areas at all. In the Republic of Macedonia, the method of underground gasification of coal is occasionally actualized in the form of various studies, but in the world is quite present. This technology has the potential to reduce greenhouse gas emissions in the process of enrichment of coal deposits. Any investment and attention paid to its development is welcome if we think for a better energy future.

Key words: coal, underground coal gasification, multicriteria range

### 1. INTRODUCTION

The underground coal gasification is one of the main technologies that enables the introduction and implementation of unconventional coal mining methods in order to minimize emissions of harmful gases. This technology provides opportunities for further ecological exploitation of the coal.

Namely, for the selected three variant solutions, 4 main criteria are selected, as well as the other six additional criteria. The selection of the criteria is made on the basis of contemporary research in this field.

Four main criteria are: minimum depth of the coal seam (is not greater than 12 meters), minimum power layer (is not less than 2 meters), ash content (not exceeding 35 %) and sulphur content (up to 5%). These four criteria give an opportunity to define a model that determines how many of the total number of investigative holes accomplish these conditions. The analysis was made for 5 values of the ash content of 15, 10, 25, 30 and 35%. These are 5 subversion solutions.

In this way, for each of the 3 variant solutions, output tables are given the percentage participation of the fulfilled 4, 3, 2 and 1 condition.

**2. SELECTION AND IDENTIFICATION OF CRITERIA FOR MULTICRITERIALRANGE**

Solving of the multi-criteria problem means choosing the "best" alternative from a variety of available alternatives, where the notion of "best" decision-maker can be interpreted as "preferred". The criteria that have the greatest influence on the model resolution have been identified.

The following 7 criteria have been selected are:

*Criterion 1: Coefficient of utilization of coal reserves*

*Criterion 2: angle downs*

*Criterion 3: Structured – tectonics characteristics*

*Criterion 4: Hydro - geological features*

*Criterion 5: Configuration field*

*Criterion 6: Charge for exploitation by conventional methods*

*Criterion 7: Ability to use conventional methods*

Multicriterial model is defined by descriptive marks required is their transformation into numerical values. For this purpose the simplest is using a linear scale transformation.

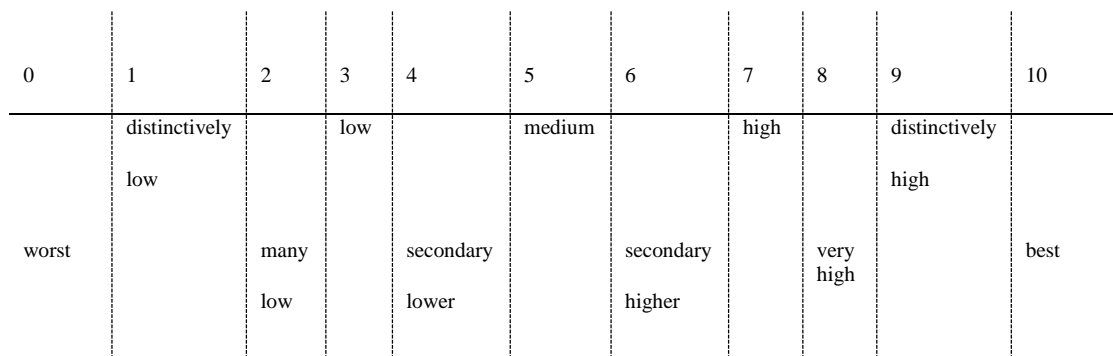


Figure. 1. Linear transformations for the quality atributs

After the transformation of the attributes qualities, the input multi-criteria model (table) is obtained. Resolving multicriterial model was made by the PROMETHEE II method. There are 6 types of common criteria: Ordinary criterion, Quasi criterion, Criteria with linear preference, Criterion level, Criteria with linear preference and indifference area, Gauss's criterion

### 3. MODEL OF MULTICRITERIUM RANGE

The entry model prepared for solving the PROMETHEE II multi-criteria method is given in the following table.

Table 1.

No.	Alternatives	Rate of efficiency of coal reserves with UCG K1	Angle K2	Structural and tectonics characteristics K3	Hydro - geological characteristics K4	Landscape approach K5	Economical value K6	Application of conventional method of exploitation K7
		%	°dec				EUR/t	
1	Alternative 1	e1	a1	c1	h1	l1	p1	m1
2	Alternative 2	e2	a2	c2	h2	l2	p2	m2
3	Alternative 3	e3	a3	c3	h3	l3	p3	m3
	MIN/MAX	MAX	MAX	MAX	MAX	MAX	MIN	MAX
W	%	50	10	10	5	5	10	10
		0.5	0.1	0.1	0.05	0.05	0.1	0.1

Resolving multicriteria model was made by the PROMETHEE II method and was used academic software version VISUAL PROMETHEE. Below are the results of the resolution of the multi-criteria model:

#### *Statistical indicators*

The following table provides basic statistical indicators for the input multi-criteria model.

Table 2. Statistical indicators

Feature	K1	K2	K3	K4	K5	K6	K7
MIN	e <sub>2</sub>	a <sub>3</sub>	c <sub>2</sub>	h <sub>2</sub>	l <sub>1</sub>	p <sub>2</sub>	m <sub>1</sub>
MAX	e <sub>3</sub>	a <sub>1</sub>	c <sub>1</sub>	h <sub>1</sub>	l <sub>2</sub>	p <sub>3</sub>	m <sub>2</sub>
Average value	Av <sub>1</sub>	Av <sub>2</sub>	Av <sub>3</sub>	Av <sub>4</sub>	Av <sub>5</sub>	Av <sub>6</sub>	Av <sub>7</sub>
Standard deviation	Sd <sub>1</sub>	Sd <sub>2</sub>	Sd <sub>3</sub>	Sd <sub>4</sub>	Sd <sub>5</sub>	Sd <sub>6</sub>	Sd <sub>7</sub>

#### Characteristics of the criterion functions

Table 3. Characteristics of criterium function

Feature	K1	K2	K3	K4	K5	K6	K7
Min/Max	max	max	max	max	max	min	max
W	0.50	0.10	0.10	0.05	0.05	0.10	0.10
Type function	Ordinary	Level	Level	Ordinary	Level	Ordinary	Level
Indiferenca	-	1.00	1.00	-	2.00	-	1.00
Preferences	-	3.00	3.00	-	5.00	-	3.00

**Net flow**

The following are the values of the net flow over the PROMETHEE II method.

Table 4. Total values according PROMETHEE II

Alternative	Phi	Phi+	Phi-
A <sub>3</sub>	0.3375	0.5625	0.2250
A <sub>1</sub>	0.1250	0.5250	0.4000
A <sub>2</sub>	-0.4625	0.1875	0.6500

**Diagrams from the determined model according to the PROMETHEE method**

After solving the multi-criteria model, the diagrams can be drawn according to the PROMETHEE method.

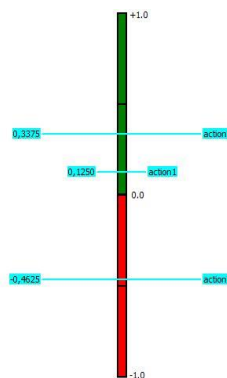


Figure.2. Diagram according PROMETHEE II method

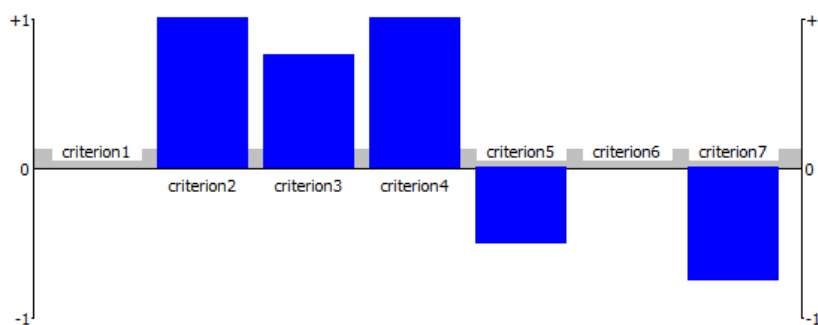


Figure. 3. Diagram of active criteriums for alternative 1

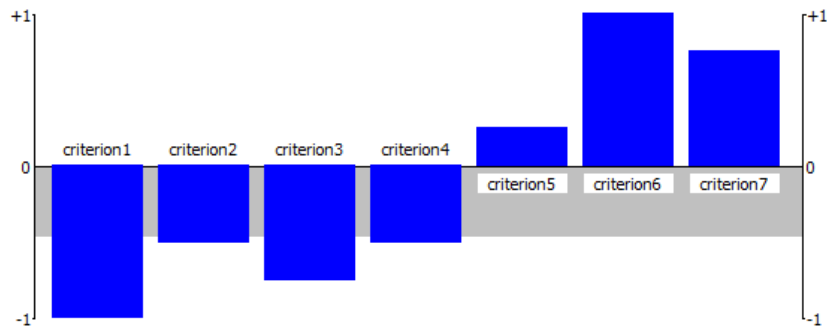


Figure. 4. Diagram of active criteriums for alternative 2

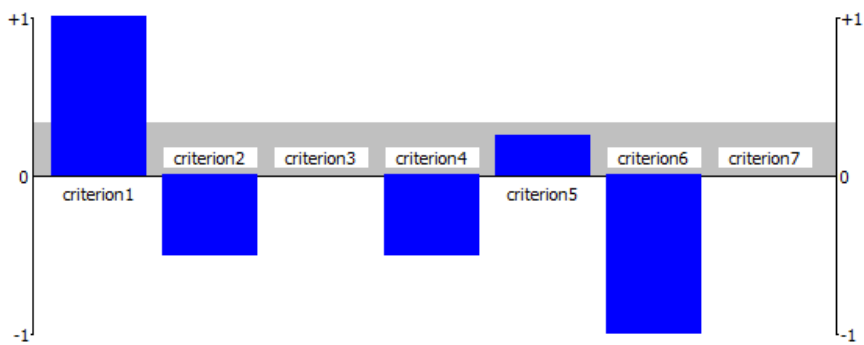


Figure. 5. Diagram of active criteriums for alternative 3

The next diagram is given PROMETHEE - GAIA analysis. GAIA (geometrical analysis for interactive aid) is an interactive geometric view of the solution from the PROMETHEE method.

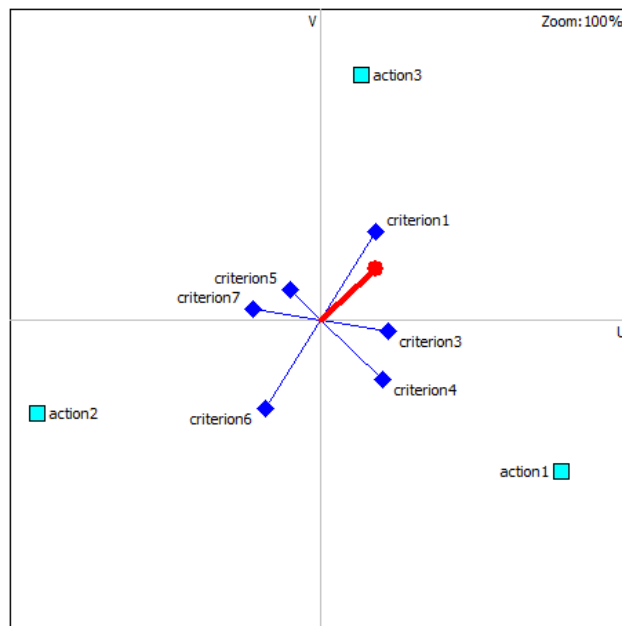


Figure.6. GAIA diagram

According to the PROMETHEE II method, it can be concluded that the first ranked alternative is Alternative A<sub>3</sub>, which has a value for the net flow of 0.3375 and has the highest priority for the application of underground gasification as a method that is environmentally acceptable. Next to the rank list is the alternative A<sub>1</sub> and without the priority with the negative value of the net flow is the alternative A<sub>2</sub>. The same is unsuitable for the application of the underground gasification technology of coal.

## 1. CONCLUSION

Coal is still one of the major energy sources in many countries in the world. According to the predictions of many well-known scientific institutes, it will be dominant in the next 20-30 years. The main problem is the emission of harmful gases during its exploitation, but above all in its combustion. The main directions in the exploration of coal are to find technology for their exploitation, but also their transformation into a gas whose combustion would be environmentally friendly, that is, it would aim for the so-called Clean technology with zero emission of harmful gases.

The Republic of Macedonia is a signatory to the Energy Community Treaty, where according to this agreement, special emphasis is put on environmental protection through the introduction of new modern technologies for exploitation of coal with minimal emissions of harmful gases.

It is necessary to make a pilot probationary exploitation for experimentally verifying the possibility of applying the technology for Underground coal gasification.

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