SERBIAN UNDERGROUND COAL MINING - CURRENT STATE AND POSSIBILITIES FOR FURTHER DEVELOPMENT

Abstract

The underground coal mining in Serbia is faced with numerous problems and difficulties for quite a long time. The outputs decrease, the equipment and technologies are obsolete, the investments in development projects are minimal, while the business economy and wages are maintained primarily due to a significant financial help of the Government.

Besides, the status of the Public Enterprise for Underground Coal Mining (JP PEU Resavica), which includes nine Serbian underground coal mines, is still unsolved. Such situation only prolongs the agony, and the only way out is the restructuring of the company and transition to the market economy.

Keywords: underground coal mining, JP PEU Resavica, restructuring, market economy

1 INTRODUCTION

Since 1992, the all underground coal mines are gathered into the Public Enterprise for Underground Coal Mining, with its head office in Resavica. This company includes eight active coal mines, situated in eastern and central Serbia (Vrska Cuka, Rembas, Ibar mines, Soko, Bogovina, Lubnica, Jasenovac and Stavalj), along with mining construction unit, RGP Alek-sinac.

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Figure 1 Coal mines included into JP PEU Resavica [8]
During the years, the company had its ups and downs, but in recent years, the trend of negative business results is more and more obvious.

Although the overall situation with the Serbian underground coal mines is not satisfactory, some of them do have preconditions for further existence, development and profitable operations. The preconditions are mainly related to the coal reserves and other development potentials. On the other hand, some of the mines are faced with possible ending of their mining operations, due to lack of coal reserves and other factors.

In that sense, the restructuring of JP PEU Resavica is inevitable. Final decision has to be made by the Government, as the owner of mining resources and the company.

2 DEVELOPMENT RESOURCES

Development resources are an important precondition for existence and successful operation of any company, as well as economy in general [1]. In the underground coal mining, most important development resources are coal reserves, equipment, technology and human resources.

2.1 Coal Reserves

Total geological coal reserves of the mines included in the Public Enterprise reach 95,457,089 t, while minable reserves are 65,709,717 t. The Soko Coal Mine is in the most favorable situation, since 61% of geological and 58% of minable coal reserves belong to this mine [2].

Table 1 Geological and minable coal reserves for coal mines of JP PEU Resavica

<table>
<thead>
<tr>
<th>Coal mine</th>
<th>Geological reserves, t</th>
<th>Minable reserves, t</th>
<th>DTE, kJ/kg</th>
<th>Energetic potential, GJ</th>
<th>Mton 1 ton=41,868 GJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vrska Cuka</td>
<td>1,506,900</td>
<td>1,114,755</td>
<td>21,110</td>
<td>23,532,478</td>
<td>562,063</td>
</tr>
<tr>
<td>Rembas</td>
<td>6,535,799</td>
<td>5,264,436</td>
<td>18,100</td>
<td>95,286,292</td>
<td>2,275,874</td>
</tr>
<tr>
<td>Ibar mines</td>
<td>2,573,120</td>
<td>2,444,464</td>
<td>14,934</td>
<td>36,506,463</td>
<td>871,942</td>
</tr>
<tr>
<td>Soko</td>
<td>58,022,430</td>
<td>38,294,804</td>
<td>18,239</td>
<td>698,458,927</td>
<td>16,682,405</td>
</tr>
<tr>
<td>Bogovina</td>
<td>2,033,740</td>
<td>1,862,902</td>
<td>16,615</td>
<td>30,955,150</td>
<td>739,351</td>
</tr>
<tr>
<td>Lubnica</td>
<td>13,528,900</td>
<td>10,146,675</td>
<td>14,349</td>
<td>145,594,640</td>
<td>3,477,468</td>
</tr>
<tr>
<td>Jasenovac</td>
<td>1,186,200</td>
<td>830,340</td>
<td>16,057</td>
<td>13,332,769</td>
<td>318,448</td>
</tr>
<tr>
<td>Stavalj</td>
<td>10,070,000</td>
<td>6,344,100</td>
<td>12,541</td>
<td>79,561,358</td>
<td>1,900,290</td>
</tr>
<tr>
<td>Total</td>
<td>95,457,089</td>
<td>65,709,717</td>
<td></td>
<td>1,123,228,046</td>
<td>26,827,841</td>
</tr>
</tbody>
</table>

By the available coal reserves, the Lubnica coal mine is in the second place, after Soko. Then, Stavalj and Rembas come. These four mines make 92% of total geological and 91% of total minable reserves. Other mines are far behind them. Total energetic potential of active coal mines reaches 1,123,228,046 GJ, or 26,827,841 tons of oil equivalents.

The balance reserves are estimated to 860 million tons, and they include active mines, remaining reserves of inactive mines, explored deposits that have not been mined yet, as well as deposits that have been partially mined by surface mining, such as Cirkovac, along with some smaller deposits.

2.2 The Available Equipment and Technology

Generally, the mines included in the Public Enterprise for Underground Coal Mining Resavica are equipped poorly and the technology is very obsolete. Technology...
of coal production has been practically un-
changed for more than fifty years. Further-
more, in some mines, like Bogovina and
Rembas, the level of mechanization was
higher in 1960’s than today. Today, there is
no mechanized coal excavation, nor mecha-
nized tunneling.

For years and decades, there were no in-
vestments into new equipment. The existing
equipment is in poor condition, obsolete and
amortized. The main job of technical sector
in the mines is to keep this equipment as
much operable as possible, so the coal pro-
duction could be maintained at a certain
level. Spare parts are an additional problem,
since it is very difficult to provide them for
such equipment. The available spare parts
are usually of poor quality, obtained from
various producers, thus making the mainte-
nance costs very high.

The applied mining methods are also
obsolete and low - productive. Most of the
mines apply some variant of pillar mining,
where coal is mined in narrow stopes by
drilling and blasting. Coal is hauled by
chain conveyors form the coal faces, and
further transport is organized through a sys-
tem of several belt conveyors.

Due to low productivity, high costs and
exceeded manual work, such system of min-
ing was abandoned many years ago in most
of the coal mines in the world. Generally,
two systems of mining are mainly applied in
modern coal mining: long wall mining and
room and pillar mining. Development of
mining equipment is following these sys-
tems. For instance, self- propelled hydraulic
support is used in long wall mining, while
numerous constructions of continuous mi-
ners were developed for the room and pillar
mining. Such machines provide high outputs
and improved safety, while reducing manual
work.

Table 2 shows some of the Continuous
Miners used in coal mines across the world
for room and pillar mining and effects of
their utilization, with their performance,
number of room entries and size of the pil-
lars in several coal mines of USA, China
and South Africa. The performance given in
meters shows the advance of entries, while
performance in tons shows the coal output
in a certain period of time.

<table>
<thead>
<tr>
<th>Coal mine</th>
<th>Type of Continuous Miner</th>
<th>Number of entries and room width</th>
<th>Pillar dimensions, m x m</th>
<th>Peak performance</th>
<th>Availability, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elkhorn (USA)</td>
<td>12CM 7X2</td>
<td>5 entries, 6 m</td>
<td>12 x 12</td>
<td>3,300 t/shift</td>
<td>96 -98</td>
</tr>
<tr>
<td>Monterey No.2 (USA)</td>
<td>12CM 12X2</td>
<td>10 entries, 7 m</td>
<td>15 x 15</td>
<td>2,500 t/shift</td>
<td>97.6</td>
</tr>
<tr>
<td>Grandall Canyon (USA)</td>
<td>12CM</td>
<td>2.23 m x 6 m</td>
<td>-</td>
<td>210 m/day</td>
<td>-</td>
</tr>
<tr>
<td>Daliuta (China)</td>
<td>12CM 18</td>
<td>6 entries, 6 m</td>
<td>15 x 15</td>
<td>2, 700 m and</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>92,000 t/month</td>
<td></td>
</tr>
<tr>
<td>Marrowbone (USA)</td>
<td>12CM 12 14CM 15</td>
<td>7 entries, 6 m</td>
<td>12 x 12</td>
<td>2,000 t/shift</td>
<td>-</td>
</tr>
<tr>
<td>Martin County (USA)</td>
<td>14CM 9X2</td>
<td>7 entries, 6 m</td>
<td>15 x 15</td>
<td>3,100 t/shift</td>
<td>97-98</td>
</tr>
<tr>
<td>Khutala (South Africa)</td>
<td>12HM 17 12HM 9</td>
<td>9 entries, 6 m</td>
<td>-</td>
<td>125,000 t/month</td>
<td>97-98</td>
</tr>
<tr>
<td>Loveridge (USA)</td>
<td>14CM 12</td>
<td>4 entries,4.7 m</td>
<td>28 x61</td>
<td>95 m/shift</td>
<td>-</td>
</tr>
</tbody>
</table>
If geological properties of the coal deposit are favorable, the long wall mining is applied. Following table shows data on applied long walls by countries.

**Table 3 Outputs achieved by long wall mining [4]**

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of long walls</th>
<th>Average output of longwall per shift, t</th>
<th>Average annual output by longwall, in million t</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>69</td>
<td>3,475</td>
<td>2,502</td>
</tr>
<tr>
<td>Australia</td>
<td>30</td>
<td>2,360</td>
<td>1,558</td>
</tr>
<tr>
<td>Great Britain</td>
<td>36</td>
<td>1,667</td>
<td>1,157</td>
</tr>
<tr>
<td>China</td>
<td>244</td>
<td>1,511</td>
<td>1,070</td>
</tr>
<tr>
<td>Canada</td>
<td>2</td>
<td>1,499</td>
<td>1,138</td>
</tr>
<tr>
<td>Germany</td>
<td>66</td>
<td>1,423</td>
<td>966</td>
</tr>
<tr>
<td>South Africa</td>
<td>8</td>
<td>1,236</td>
<td>1,020</td>
</tr>
<tr>
<td>Poland</td>
<td>350</td>
<td>1,190</td>
<td>744</td>
</tr>
<tr>
<td>Russia</td>
<td>432</td>
<td>696</td>
<td>418</td>
</tr>
<tr>
<td>Ukraine</td>
<td>429</td>
<td>520</td>
<td>312</td>
</tr>
</tbody>
</table>

Long walls in the USA have provided the highest coal outputs, due to application the newest achievements in mining science, technique and technology, as well as favorable geological properties.

**2.3 Human Resources**

In a period between 2004 and 2015, the number of employees in JP PEU Resavica decreased drastically, by 23%. In recent years, the number of employees is around 4,000. [5]
Rembas and Soko are the leading mines in number of employees, while Vrska Cuka is at the bottom. The average age of employees is around 40. There were many analyses regarding the structure of employees in the company, and they have all shown that there is an excess of non-production (administration) employees, while there is a lack of production employees at the same time. It is expected that this problem would be solved through restructuring the company.

3 PRODUCTION AND ECONOMIC EFFECTS

Business results of the company vary a lot, both by years and by sectors, which is a sign of certain instability.

3.1 Coal Production

From the moment when the company was created, the coal production, with some oscillations, has a trend of constant decrease. From 960,973 t of excavated coal in 1992, it came down to 560,651 t in 2015. It means that the coal production was reduced by 400,322 t, or 42%. [5]

Top coal producers in the company are Rembas, Soko and Stavalj mines, while Vrska Cuka is on the bottom. The dominant type of coal is brown coal. Most of extracted coal is used for production the electric energy and domestic purposes.

There were many circumstances that led to decrease of coal production. As it was mentioned before, poor technical equipment is one of the reasons. That is why the production effects are also unfavorable: coal recovery is around 60%, low productivity (138 tons of coal per employee in 2015, 6 – 20.9 tons of coal per employee at coal face, 5.3 – 8.85 t of coal per employee in coal section, 50 – 169 t of coal per shift by mine, etc.

![Figure 3 Coal outputs in JP PEU Resavica from 1992 to 1995](image)

For example, in the Kazemir – Julius mine in Poland, due to the modern equipment and highly mechanized processes, the effects of production process are following: 500 t is a daily output from a single coal face, with 20 employees on the sublevel
coal face (4 shifts with 5 employees), coal recovery is 65-75%, productivity at the coal face is 25 t per day for 6 working hours, the annual output per employee is 1,667 t, etc.

Besides, there is also a problem of lack of employees in production, along with lack of financial resources, both for ongoing production process and investments and development projects. If there is no significant change in this situation, it is realistic to expect further decrease of production.

3.2 Business Economy

The realized production effects have a direct influence to the business economy of the company. In recent years, business results are mainly negative. In last five years, the company managed to gain profit only in 2014 [5].

Total loss in the observed period exceeds 8 billion RSD. Due to such business results in a long period of time, the cumulative loss exceeds the capital value of the company.

It should be added that the loss would be much higher without significant subventions from the government. In some years, these incomes exceeded the value of sold coal. In 2015, almost 70% of incomes came from subventions.

### Table 4

<table>
<thead>
<tr>
<th>Year</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total income</td>
<td>5,678,874</td>
<td>5,833,109</td>
<td>7,850,001</td>
<td>8,250,699</td>
<td>10,587,381</td>
<td>6,537,148</td>
</tr>
<tr>
<td>Total expense</td>
<td>7,084,645</td>
<td>7,810,450</td>
<td>9,948,069</td>
<td>8,520,829</td>
<td>7,728,293</td>
<td>8,997,240</td>
</tr>
<tr>
<td>Profit (P) / Loss (L)</td>
<td>L 1,405,771</td>
<td>L 1,977,341</td>
<td>L 2,048,068</td>
<td>L 320,130</td>
<td>P 2,859,088</td>
<td>L 2,460,092</td>
</tr>
</tbody>
</table>

Source: Documentation of JP PEU Resavica and Serbian Business Registry Agency

The reasons for such business results are low productivity and high costs. In 2015, the cost price of a produced ton of coal was 13,161 RSD. At the same time, the average selling price, with all subventions, was 13,734 RSD. A difference between these two prices is minimal and inadequate to cover all of the business costs.

It should also be mentioned that the selling price of coal is determined administratively, and it is very low because it is a measure of protecting the life standard for households which use coal for heating. However, this measure is only applied to the coal producers, i.e. coal mines. Price of coal on the market is determined freely. This means that the coal prices at the dealers are 50 to 70% higher than the prices for the coal mines.

Wages in the company are pretty modest, especially considering extremely hard working conditions. In 2015, the average net wage reached 50 thousand RSD, which is some 10% above the average in the Republic of Serbia.

Also, the economy of resources is unfavorable. The company practically does not have its own financial means. Instead, its business economy is based on subventions and borrowed financial means. It makes every day operations very difficult and increases the costs.

### 4 POSSIBILITIES FOR FURTHER DEVELOPMENT

The current situation in JP PEU Resavica is unsustainable. Production keeps
decreasing, while the losses rise. Restructuring of the company is the only solution, along with readjustment to the modern, market based business environment.

A plan for consolidation of the company and further development was made in 2013 [6]. By this plan, the company should be consolidated first, thus making the base for profitable economy and long term sustainable development. In that sense, the investments were planned for mines with best development potentials, in order to raise their outputs (up to 300,000 t of coal for Soko and 2,000,000 t for Stavalj, along with the new Thermal Plant).

Based on the exploration works, some investments would be directed to opening and coal extraction in deposits that are not currently active, or only partially active, such as the Western Field of the Stavalj Mine, Cirikovac, Poljana, Kosa Zabela, Melnica and Western Morava Coal Basin. That way, domestic needs for this type of coal would be fulfilled. Also, the deposits of oil shale and borate minerals are planned for extraction.

Finally, the mines with low-grade coal reserves would be gradually closed. This group of mines includes Tadenje, Jarando, Vrška Cuka, Eastern Field and Senje Mine.

Naturally, such ambitious plan requires the significant financial resources, which are difficult to provide, especially with favorable interest. In that sense the Government, as the owner of the company, has a decisive role and huge responsibility.

CONCLUSION

The underground coal mining is an important segment of entire mining complex in the Republic of Serbia. Although its share in total coal production is minor, around 1.5%, it has an important role in supplying the thermal plants, industry and households with this product. The underground coal mining provides anthracite, hard coal, brown coal and lignite. Coal, as an input, covers 70% of electric energy production in Serbia.

In recent years, the underground coal mining, organized through the Public Enterprise for Underground Coal Mining (JP PEU Resavica), comes through deep crisis. Decrease of production, lagging in technique and technology, business loss, unfavorable economy of resources and similar, are the main characteristics of this company’s reality.

The exit from such situation exists. The Government, as the owner, has announced the restructuring. Company itself made a plan of consolidation a couple of years ago. The essence of changes is to invest in mines with good development possibilities in order to modernize them and increase the production significantly, and at the same time to gradually close the mines with low coal reserves and without development potentials. All of these has to be followed by measures of macroeconomic consolidation, with inclusion the eventual strategic partners.

REFERENCES

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