

## Revision of coal reserves and placement of exploitation fields in exploitation of the lignite deposit in Premogovnik Velenje

### Revizija rezerv premoga in umeščanje odkopnih polj pri eksploataciji ležišča lignita v Premogovniku Velenje

MILAN MEDVED<sup>1</sup>\*, BOJAN LAJLAR<sup>1</sup>, VLADIMIR MALENKOVIČ<sup>2</sup>, EVGEN DERVARIČ<sup>3</sup>

<sup>1</sup>Premogovnik Velenje, d. d., Partizanska 78, SI-3320 Velenje, Slovenia

<sup>2</sup>HTZ, I. P., d. o. o., Partizanska 78, 3320 Velenje, Slovenia

<sup>3</sup>University of Ljubljana, Faculty of Natural Sciences and Engineering, Aškerčeva 12, SI-1000 Ljubljana, Slovenia

\*Corresponding author. E-mail: milan.medved@rllv.si

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**Abstract:** Coal (brown coal and lignite) is the only fossil fuel available in Slovenia, representing approximately 21 % of primary energy consumption. Due to environmental reasons, the use of coal is directed only to thermal energy generating facilities with appropriate flue gas cleaning technologies.

Premogovnik Velenje (PV) is a modern equipped and highly productive coal mine providing lignite exclusively to Termoelektrarna Šoštanj for its production of electricity and thermal energy. PV exploits a deposit of exceptional dimensions in which they developed their own, highly productive exploitation method with underground production and can compete, in productivity and coal prices, with the world's best underground coal mines. The quantities of domestic production of coal cover 78.0 % of all planned demands for solid fuels.

In the Šaleška dolina valley, the balance sheet reserves of coal in coal deposit in PV amount to 171 million tonne on 31st December 2008 and 131,67 million tonne of exploitation reserves with average calorific value of 10.47 GJ/t. Projections for further production of coal are related to long-term operation of the Šoštanj Thermal Power Plant (TEŠ) which will invest in the 600 MW generator unit 6. PV is the only supplier of coal for TEŠ. Until the year 2021, the level

of production of coal will amount to 4 million tonne per year. In the period until the year 2040, it will gradually decrease to the level of 2 million tonne per year and will remain at this level until the end of exploitation of the Velenje exploitation field in the year 2054.

**Izveček:** Premog (rjavi premog in lignit) je edino fosilno gorivo, ki je na razpolago v Sloveniji in pomeni približno 21 % rabe primarne energije. Zaradi okoljskih razlogov je uporaba premoga usmerjena le na termoenergetske objekte, ki imajo ustrezne tehnologije čiščenja dimnih plinov.

Premogovnik Velenje (PV) je moderno opremljen in visoko produktiven premogovnik, ki lignit dobavlja izključno Termoelektrarni Šoštanj za proizvodnjo električne energije in toplote. PV izkorišča nahajališče izjemnih dimenzij, v katerem je razvil lastno, visoko produktivno odkopno metodo s podzemno proizvodnjo, ki se po produktivnosti in ceni premoga kosa z najboljšimi podzemnimi premogovniki v svetu. Količina domače proizvodnje premoga zadostuje za 78,0 % vseh načrtovanih potreb po trdnih gorivih.

V Šaleški dolini ležišče premoga v PV je na dan 31. 12. 2008 razpolagalo s 171 milijoni ton bilančnih zalog, od tega je 131,67 milijona ton eksploatacijskih zalog s povprečno kurilno vrednostjo 10,47 GJ/t. Projekcije za nadaljnjo proizvodnjo premoga so vezane na dolgoročno obratovanje Termoelektrarne Šoštanj (TEŠ), ki bo izvedla investicijo v blok 6 moči 600 MW. PV je edini dobavitelj premoga za TEŠ. Velikost proizvodnje premoga bo do leta 2021 4 milijone ton na leto, do leta 2040 bo postopno upadala do 2 milijona ton na leto in se na tem nivoju obdržala do konca eksploatacije velenjskega odkopnega polja v letu 2054.

**Key words:** coal, exploitation reserves, exploitation field, exploitation losses

**Ključne besede:** premog, eksploatacijske rezerve, odkopno polje, odkopne izgube

## INTRODUCTION

Long-term plans of Premogovnik Velenje are closely connected to electricity generation in the thermal power

plant Termoelektrarna Šoštanj. Exploitation of coal in PV is carried out in three mines or areas divided to the mine Pesje, and the mine Preloge which is divided to south and north

wing. In the mines Pesje and Preloge, the exploitation is carried out at long-wall exploitation sites measuring 130 m to 160 m with exploitation height of 10 m or more, and in the north part of the mine Preloge, the dimension of exploitation floors exceed long-wall lengths of 200 m or more, but the exploitation height is, in accordance with the criteria for safe exploitation, limited to 6 m. With the export report: »Revision of coal reserves in Premogovnik Velenje based on conceptual solutions until the finalisation of exploitation in the Velenje exploitation field«, the reserves of coal in individual exploitation fields and their development until the finalisation of exploitation in the Velenje exploitation field were verified at the Faculty of Natural Sciences and Engineering in Ljubljana. The purpose of this article is to present basic reference points for exploitation of coal until the year 2054, i.e. until the time when all reserves in this field will have been exploited.

### **Geological and hydrogeological conditions in the deposit**

Geological and hydrogeological conditions in the deposit were well researched in the past. All findings of the geological and hydrogeological research were taken into consideration in the elaboration of conceptual solutions for the excavation presented in the continuation of the text.

### **Geology**

Geologic data was acquired by research work (drilling) performed both on the surface and in the mine and by monitoring of the constructed lines. 705 bores were drilled from the surface, in the total length of 205 km. 2265 bores were drilled from the mine facilities, with the total length of approximately 90 km.

The acquired data give an excellent image of the entire coal deposit (coal layer, footline layers, hanging wall layers) Based on these data, conceptual solutions have been elaborated to enable precise calculations of the amounts of coal exploited in the future according to the processed conceptual solutions.

### **Hydrogeology**

Hydrogeological research of the layer, footline and hanging wall layers, carried out in the previous period, gave all hydrologic factors that have to be considered for safe exploitation. Based on analyses of this data, the drainage measures were adopted (drainage of sands in the hanging wall, drainage of the Triassic base, drainage of lithothamnium limestone) to establish conditions for exploitation on the entire coal layer in the mine Velenje.

### ***Drainage of first sands above the coal layer***

In the last three decades, there was in-

tensive draining of Pliocene sands in the hanging wall by drainage facilities both from the surface and from the mine. In the wider area of the north wing and the central part, water pressures were lowered by more than 20 bar, so for further exploitation it was only necessary to maintain the existing status by constructing impress filters from the mine facilities.

### ***Drainage of the Triassic base***

Triassic stones representing the base in the area of the north wing and in the mine Škale, have been in the last few decades intensively drained by drainage facilities constructed from the mine (the upper height points of the Triassic base are shown in Annex No. 3).

The underground water levels have been lowered by more than 300 m. The current situation of groundwater levels is shown in Annex No. 4 and provides safe exploitation of the entire coal layer in the area of the mine Velenje. It is understandable that such situation will have to be maintained and monitored until the finalisation of the exploitation.

### **Excavation technology and permitted excavation heights**

The excavation of the layer covered in the conceptual solutions will be performed with the Velenje long-wall exploitation method described in the mining project »Velenje exploitation

method«, project No.: RP-36/95 ML, Rudnik lignita Velenje. The method is still being developed and improved in the technological and organisational point of view, particularly in the sense of increasing production from one excavation, increasing the efficiency rate of a layer, employee safety, humanisation of work and better economy.

### **Conceptual solutions to excavation**

In Premogovnik Velenje, coal production is currently running in two mines, i.e.:

- in the mine Pesje and
- in the mine Preloge (south and north wing).

Permits for execution of works in these areas were acquired on the basis of the following mining projects:

- »Supplementing of the concept of exploitation of the north-western section of the mine Preloge«, RP-183/2000 ML,
- »Preparation and exploitation of the panel G1/A«, RP-205/2001ML,
- »Continuation of excavation in the mine Pesje from k. +40 to k. -40«, RP-13/91,
- »Continuation of exploitation in the south wing of the mine Preloge until the finalisation of exploitation«, RP-54/91.

The above listed conceptual solutions covered the production of PV until the year 2025.

With the purpose of prolonging the production of coal at PV, they initiated a search for conceptual solutions for the continuation of exploitation in the existing mines (the hanging wall section and the footwall section of the mine Pesje, the north wing of the mine Preloge) and for opening a new part of the mine Preloge called CD pillar. In March 2007, the mining project »Exploitation of the mine Pesje from k. –40 to the depression bottom and CD pillar«, project No.: RP-325/007TK, was prepared, followed by the expert report »Exploitation of the north wing of the mine Preloge«, expert report No.: TK002/07, in June 2007.

Coal for further production of PV is still available in the remaining pillars and in the areas where excavation was abandoned in the past.

### **Delimitation of mines of Premogovnik Velenje**

With the decision on exploitation of the pillar between the north and the south wing of the mine Preloge, the needs emerged for denomination of the pillar and reasonable separation of the mine Preloge. It should be noted that the delimitation has been elaborated at the level of the first floor of CD pillar. The area is wider in the depth and it extends to the exploited part of the south wing of the mine Preloge in the south and to the exploited part of the north wing of the mine Preloge in the north.

The mine Pesje is spreading westward where significantly different conditions for coal exploitation appear compared to the existing area, so it was divided in the footwall section and the hanging wall section. It should be noted that the delimitation has been elaborated at the level of the floor k. –50 in the mine Pesje.

### **Basic reference points and considered principles in the search of conceptual solutions for the preparation and exploitation in the mines of Premogovnik Velenje**

#### ***The mine Pesje – Footwall section***

In searching for technical solutions for the preparation and exploitation of this area, the following limitations and requirements were taken into consideration:

- limitations of the exploitation field: on the eastern side the exploitation field is limited by the border of quality coal, on the southern side the exploitation field is limited by the pillar protecting the facilities on the surface, on the northern side the area is limited by the exploited floors of the former north wing of the mine Preloge, and on the western side the area enters the hanging wall section of the mine Pesje,
- the area is exploited in the direction from north-east to south-west, with the excavations following from

footline to hanging wall (from east to west),

- the floor height in the footline section of the mine Pesje amounts to 15 m,
- the footline section of the mine Pesje is ventilated with fresh air from entrance ventilation network of the NOP shaft over the conveyance line to the excavation site and over the delivery line into the exit ventilation network of the ventilation shaft Pesje,
- in the footline section of the mine Pesje, there is no simultaneous operation of several excavations,
- a pillar between two excavation panels on a floor amounts to 15 m and is acquired at the next floor,
- the width of excavation panels is up to 140 m,
- the length of remaining conveyance line after excavation is at least 80 m (currently necessary length for the dismantling of conveyance machinery),
- the conveyance line is at the hanging wall side,
- the existing mine facilities are used to the greatest extent.

### ***The mine Pesje - Hanging wall section***

From the geological and hydrogeological point of view, the hanging wall section of the mine Pesje is very similar to the area of north wing of the mine

Preloge. The following requirements arise from the mining project »Velenje exploitation method«, project No. RP-36/95 ML and from the mining project »Supplementing of the concept of exploitation of the north-western and central section of the mine Preloge«, project No. RP-183/2000 ML:

- the placement of exploitation panels in the coal layer must ensure that the crumbling process in the areas with smaller thickness of isolation layers is entirely carried out in coal,
- the coal remaining above the first exploitation panel (where the crumbling process took place) must not remain uncrumbled in must not be exploited on the following floors,
- intermediate pillars between the exploitation panels are not permitted and are collected with the blind section of the excavation,
- all passages in excavation must be gradual.

Considering the above mentioned aspects, the following limitations and requirements were taken into consideration while searching for technical solutions for the preparation and exploitation of this area:

- limitations of the exploitation field: in the east the area is limited by the hanging wall section of the mine Pesje, on the south-eastern side the exploitation field is limited by the

pillar protecting main connections for the area in question and the mine Preloge, on the western side the area enters the north wing of the mine Preloge, on the north-eastern side the area is limited by excavated floors of the former north-eastern wing of the mine Preloge,

- the area is exploited in the direction from north-east to south-west, with the excavations following from west to east,
- the hanging wall section of the mine Pesje will be exploited as follows: in the area where the isolation layer is thinner than 15 m, coal will only be exploited from the footline section, and in the area where the isolation layer is thicker than 15 m, coal will be exploited from the hanging wall section as well; in such events, a gradual transition from footline exploitation to hanging wall exploitation will be necessary,
- planned excavation height of the exploitation panels in the hanging wall section of the mine Pesje is 8–10 m. Planned excavation height of the substratum will be 6 m,
- the hanging wall section of the mine Pesje is ventilated with fresh air from entrance ventilation network of the NOP shaft over the conveyance line to the excavation site and over the delivery line of the excavation site into the exit ventilation network of the ventilation shaft

Šoštanj,

- in the footline section of the mine Pesje, there is no simultaneous operation of several excavations,
- a pillar between two excavation panels in the area in question amounts to 20 m and is acquired from the blind area at the conveyance side of the excavation,
- the width of excavation panels is up to 150 m,
- the length of remaining conveyance line after excavation is at least 80 m (currently necessary length for the dismantling of conveyance machinery),
- the conveyance line is on the eastern side,
- the existing mine facilities are used to the greatest extent.

In the mine Pesje, simultaneous operation of two exploitation panels is planned (one in the hanging wall section and one in the footline section), according to the system A-F, B-E and C-D. The exploitation sites C and D start excavation works in a 3-month interval.

#### ***The Mine Preloge - CD pillar***

From the geological and hydrogeological point of view, the area of CD pillar is very similar to the area of north wing of the mine Preloge. Similar requirements to those in the hanging wall section of the mine Pesje were taken in

consideration here. Other limitations and requirements are the following:

- limitations of the exploitation field: on the eastern side the area is limited by the protective pillar for exploitation panels of the hanging wall section of the mine Pesje, on the southern side the exploitation field extends to the south wing of the mine of Preloge, on the western side the area is limited by the facilities protecting the main mine pumping site at k. -130, and on the northern side the area enters the G panels of the north wing of the mine Preloge,
- the area is exploited in the direction from east to west, with the excavations following from north to south,
- in the area where the isolation layer is thinner than 15 m, coal will only be exploited from the footline section, and in the area where the isolation layer is thicker than 15 m, coal will be exploited from the hanging wall section as well. In such events, a gradual transition from footline exploitation to hanging wall exploitation will be necessary,
- planned excavation height of the exploitation panels in the hanging wall section of CD pillar is 8–10 m (in the section where the superstratum is exploited). Planned excavation height of the substratum will be 6 m.
- excavations in CD pillar are venti-

lated with fresh air from entrance ventilation network of the entrance ventilation shaft Šoštanj II over the delivery line to the excavation site and over the conveyance line into the exit ventilation network of the ventilation shaft Šoštanj,

- there is no simultaneous operation of several excavations in CD pillar,
- a pillar between two excavation panels on a floor amounts to 20 m and is acquired from the blind area at the conveyance side of the excavation,
- the width of excavation panels is up to 215 m,
- the length of remaining conveyance line after excavation is at least 80 m,
- the conveyance line is on the southern side,
- the existing mine facilities are used to the greatest extent.

### ***North wing***

The following requirements arise from the mining project »Velenje exploitation method«, project No. RP-36/95 ML and from the mining project »Supplementing of the concept of exploitation of the north-western and central section of the mine Preloge«, project No. RP-183/2000 ML and must be taken into consideration while planning the excavation in this area:

- the placement of exploitation panels in the coal layer must ensure



that the crumbling process in the areas with smaller thickness of isolation layers is entirely carried out in coal,

- the coal remaining above the first exploitation panel (where the crumbling process took place) must not remain uncrumbled in must not be exploited on the following panels,
- intermediate pillars between the exploitation panels are not permitted and are collected with the blind section of the excavation,
- all passages in excavation must be gradual.

Considering the above mentioned aspects, the following limitations and requirements were taken into consideration while searching for technical solutions for the preparation and exploitation of this area:

- limitations of the exploitation field: on the eastern side the exploitation field is limited by the hanging wall section of the mine Pesje, on the southern side the exploitation field is limited by the pillar protecting the main communications for the north wing of the mine Preloge, on the northern side the area is limited by the border of quality coal and by an area with thin isolation layer in the hanging wall, and on the western side the area is limited by the border of quality coal,
- the area is exploited in the direction

from north to south, with the excavations following from footline to hanging wall (from west to east),

- the floor height in the north wing of the mine Preloge amounts to 9 m,
- the north wing of the mine Preloge is ventilated with fresh air from entrance ventilation network of the entrance ventilation shaft Šoštanj II over the delivery line to the excavation site and into the exit ventilation network of the ventilation shaft Šoštanjin the north wing of the mine Preloge, there is no simultaneous operation of several excavations,
- a pillar between two excavation panels on a floor amounts to 20 m and is acquired from the blind area at the conveyance side of the excavation,
- the length of remaining conveyance line after excavation is at least 80 m,
- the existing mine facilities are used to the greatest extent.

Exploitation of G area will be performed according to the Velenje exploitation method (mining project »Velenje exploitation method«, project No.: RP-36/95 ML). On all panels of G area, the exploitation will be carried out by excavation of coal from the substratum of the exploitation site.

Permitted exploitation heights in the north wing of the mine Preloge have

been determined on the basis of the expert report »Hydrogeological basis for exploitation of the mine Preloge and CD pillar« (expert report No.: 01/07-HGS) and amount to 6 m, while floor heights amount to 9 m.

### ***South wing***

From the geological and hydrogeological point of view, the south wing of the mine Preloge is not a demanding area for exploitation. In searching for technical solutions for the preparation and exploitation of this area, the following limitations and requirements were taken into consideration:

- limitations of the exploitation field: on the eastern side the exploitation field is limited by the pillars protecting the main communications for the north wing of the mine Preloge, on the southern side the exploitation field is limited by the pillar protecting the facilities on the surface and by the border of quality coal, on the northern side the area is limited by the pillar protecting the main ventilation facilities of the ventilation network of the ventilation shaft Šoštanj, and on the western side the area is limited by the pillar protecting the facilities of the ventilation network of the ventilation shaft Šoštanj.
- the area is exploited in the direction from west to east, with the excavations following from footline to

- hanging wall (from south to north),
- the floor height in the south wing of the mine Preloge amounts to 10 m,
- the south wing of the mine Preloge is ventilated with fresh air from entrance ventilation network of the shaft NOP over the conveyance line to the excavation site and into the exit ventilation network of the ventilation shaft Šoštanj,
- in the south wing of the mine Preloge, there is no simultaneous operation of several excavations,
- a pillar between two excavation panels on a floor amounts to 20 m and is acquired at the next floor,
- the length of remaining conveyance line after excavation is at least 80 m,
- the existing mine facilities are used to the greatest extent.

### **Temporal integration of excavation in the relevant area**

The exploitation fields in Premogovnik Velenje are mutually approaching, which causes an increase of their mutual influence dictating reasonable integration of individual exploitation fields and individual exploitation panels to achieve the necessary production dynamics.

Exploitation of coal in the south wing of the mine Preloge will continue in the current manner to the depression bottom - presumably to the floor k. -140.

Roadways of the exploitation panel on the floor k. –140 will be used as connections for CD pillar and the north wing of the mine Preloge from the floor G3 on. It will be exploited after finalised exploitation of the mentioned areas.

The exploitation field CD pillar will be included in the production after finalised exploitation in the south wing of the mine Preloge and after finalised exploitation of the third level of G panels in the north wing of the mine Preloge. Three more levels of CD pillar will be exploited, followed by the exploitation of the G area where three further levels will be exploited. The exploitation will continue in the same sense to the bottom of the coal layer in both areas.

The integration of exploitation panels in the mine Pesje will be carried out depending on the advancement of exploitation of G area. The contact between the G area and the mine Pesje is situated in the area with thinner isolation layers. In order to preserve them intact, the deepening of the mine Pesje in this area must follow the deepening of the G area in a timely manner.

### **Spatial integration of exploitation of the treated areas**

#### ***Spatial integration of the south wing of the mine Preloge***

Exploitation of the south wing of the

mine Preloge will continue to the depression bottom (presumably to the fl. –140). Roadways to the excavation sites will be connected to the existing main lines.

Roadways of the exploitation panel k. –140 will be used as connections for the exploitation of CD pillar and the north wing of the mine Preloge. According to valid concepts, it will be exploited after finalised exploitation of the mentioned areas.

#### ***Spatial integration of the north wing of the mine Preloge***

Exploitation of the north wing of the mine Preloge will be continued to the exploitation site G3/C. Due to demanding dynamics of excavation, this exploitation must be included in the production process after the exploitation site F k. –65 which will represent the first exploitation of the hanging wall section of the mine Pesje and will demolish the existing connections for the G area. They will be replaced by the above mentioned roadways of the exploitation site k. –140 and new connections of the hanging wall section of the mine Pesje.

After the third level of G panels, three levels of CD pillar will be exploited, followed by the preparations for the fourth level of CD pillar which will serve as a connection for the remaining levels of the G area.

### ***Spatial integration of the mine Pesje from k. –40 on***

With the existing main lines in the mine Pesje, it will be possible to connect to the exploitation panels of the floor k. –50 and exploitation panels A and B on the floor k. –65. For the connection of other exploitation sites in the mine Pesje, a construction of new main lines will be necessary.

### ***Spatial integration of CD pillar***

The beginning of exploitation of CD pillar is planned for the year 2012. Until then, the exploitation in the mine Pesje will take place on the floor k. –65, spreading to the hanging wall section of the mine Pesje. The exploitation panel F k. –65 will demolish the main connections for the G area. For these reasons, new main communications for the G area and CD pillar will be constructed and will, after finalised excavations in

the mentioned area, serve as roadways for the exploitation site k. –140.

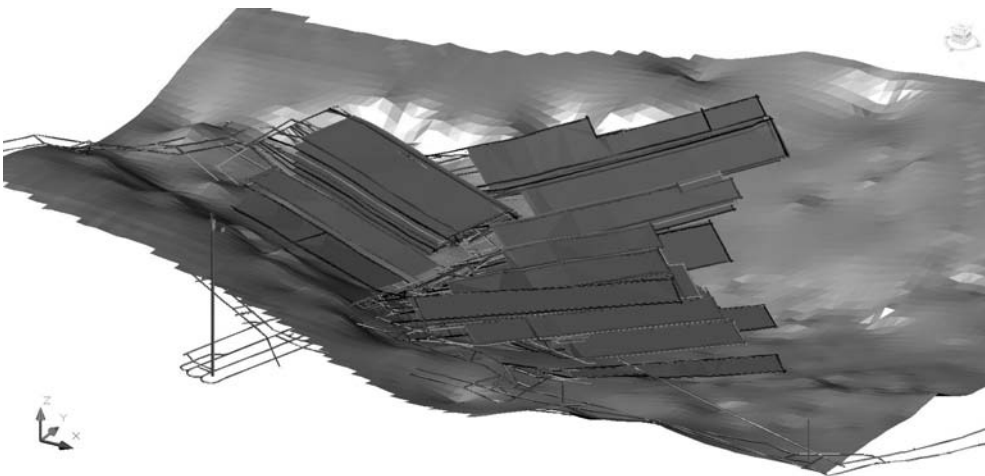
The spatial integration of Velenje coal mine exploitation area is shown on Figure 1.

### **Excavation parameters**

The parameters for preparation and exploitation for the panels exploited with the currently known technology are shown below. The technology may change in the future, which will influence the preparation and exploitation of the panels, also in the sense of a better efficiency rate of the layer.

### ***The mine Pesje***

Parameters for excavation of exploitation panels at floors k. –50, k. –65 and k. –80 in the mine Pesje are shown in Tables 1 to 3.



**Figure 1.** Velenje coal mine exploitation fields

**Table 1.** Parameters at excavation of floor level k. –50

ET. k. –50		A k. –50	B k. –50	C k. –50	Total
Excavation panel length	m	434	670	680	1 784
Excavation panel width	m	140	140	140	420
Total roadways	m	2 298	1 130	1 664	5 092
Advancement of development works	m/d	5.0	5.0	5.0	
Production of development works	t	59 748	29 380	43 264	132 392
Advancement of excavation panel	m/d	4.2	3.3	4.6	
Production of excavation panel	t	1 088 589	1 696 324	1 565 678	4 350 591
Length of transport routes	m	1 670	1 550	1 430	
Length of demolished roadways	m	310	525	321	
Calorific value	MJ/kg	9.36	10.85	11.76	
Energy from excavation panels	GJ	10 189 193	18 405 115	18 412 373	47 006 682
<b>Total energy</b>					<b>48 447 566</b>

**Table 2.** Parameters at excavation of floor k. –65

ET. k. –65		A k. –65	B k. –65	C k. –65	D k. –65	E k. –65	F k. –65	Total
Excavation panel length	m	433	678	670	614	427	440	3 262
Excavation panel width	m	131	131	131	134	118	147	792
Total roadways	m	2 250	1 133	1 770	1 775	1 360	2 580	10 868
Advancement of development works	m/d	5.0	5.0	5.0	5.0	5.0	5.0	
Production of development works	T	58 500	29 458	46 020	46 150	35 360	67 080	282 568
Advancement of excavation panel	m/d	4.6	4.6	3.3	3.3	6.0	4.8	
Production of excavation panel	t	977 200	1 606 021	1 565 957	1 272 004	437 474	548 787	6 407 443
Length of transport routes	m	1 635	1 530	1 400	1 570	1 640	1 840	
Length of demolished roadways	m	440	450	257	386	380	150	72 210 077
Calorific value	MJ/kg	9.50	10.85	11.71	12.02	12.09	12.00	
Energy from excavation panels	GJ	9 283 400	17 425 328	18 337 356	15 289 488	5 289 061	6 585 444	
<b>Total energy</b>								<b>75 413 909</b>

**Table 3.** Parameters at excavation of floor k. –80

ET. k. –80		A k. –80	B k. –80	C k. –80	D k. –80	E k. –80	F k. –80	Total
Excavation panel length	m	358	681	742	590	410	397	3 178
Excavation panel width	m	130	130	130	135	140	134	799
Total roadways	m	2 240	983	1 935	1 730	1 340	1 160	9 388
Advancement of development works	m/d	6.0	6.0	6.0	6.0	6.0	6.0	
Production of development works	T	58 240	25 558	50 310	44 980	34 840	30 160	244 088
Advancement of excavation panel	m/d	3.5	3.7	3.1	3.4	5.2	5.0	
Production of excavation panel	t	935 622	1 834 813	1 968 334	1 178 527	476 890	551 022	6 945 208
Length of transport routes	m	1 645	1 570	1 440	1 600	1 680	1 850	76 794 319
Length of demolished roadways	m	330	420	260	380	380	190	
Calorific value	MJ/kg	9.06	10.57	11.46	11.94	12.02	11.91	
Energy from excavation panels	GJ	8 476 735	19 393 973	22 557 108	14 071 612	5 732 218	6 562 672	
Total energy								79 513 100

Parameters at exploitation of the entire area of the mine Pesje from k. –40 to the depression bottom:

- planned production 48 037 315 tonne
- average calorific value of coal 9.8 GJ per tonne
- planned production of energy 470 765 687 GJ
- required length of constructed lines 60 800 m
- planned production of appliances 1 580 800 tonne
- norm for construction of lines 1.22 m per 1000 tonne

***CD pillar in the mine Preloge***

Parameters for excavation of exploitation panels at the first three levels of CD pillar in the mine Preloge are shown in Table 4:

**Table 4.** Parameters for excavation of the first three levels of CD pillar

CD1-3		CD1	CD2	CD3/a	CD3/b	Total
Excavation panel length	m	677	658	635	635	2 605
Excavation panel width	m	190	222	112	120	644
Total roadways	m	4 780	2 005	1 880	1 620	10 285
Advancement of development works	m/d	5.0	5.0	5.0	5.0	
Production of development works	T	124 280	52 130	48 880	42 120	267 410
Advancement of excavation panel	m/d	3.0	3.9	4.0	5.0	
Production of excavation panel	t	1 458 664	1 252 237	743 133	796 214	4 250 248
Length of transport routes	m	3 150	3 150	3 100	3 020	50 368 923
Length of demolished roadways	m	185	210	250	250	
Calorific value	MJ/kg	12.00	11.89	11.60	11.75	
Energy from excavation panels	GJ	17 503 968	14 889 098	8 620 343	9 355 515	
Total energy						53 538 425

Parameters at exploitation of the entire area of CD pillar:

- planned production 13 808 321 tonne
- average calorific value of coal 10.35 GJ per tonne
- planned production of energy 142 916 122 GJ
- required length of constructed lines 25 640 m
- planned production of appliances 666 640 tonne
- norm for construction of lines 1.77 m/ per1000 tonne

### *South wing of the mine Preloge*

Parameters for excavation of exploitation panels of the south wing of the mine Preloge are shown in Table 5:

**Table 5.** Parameters for excavation of the south wing of the mine Preloge

Preloge		A k. -120	B k. -120	A k. -130	B k. -130	Total
Excavation panel length	m	686	732	690	700	2 808
Excavation panel width	m	103	136	104	92	435
Total roadways	m	1 774	2 090	1 900	1 780	7 544
Advacement of development works	m/d	5.0	5.0	5.0	5.0	
Production of development works	T	46 124	54 340	49 400	46 280	196 144
Advancement of excavation panel	m/d	5.0	3.9	4.0	5.0	
Production of excavation panel	t	986 840	1 373 985	1 115 774	953 989	4 430 588
Length of transport routes	m	1 250	1 125	1 050	980	41 654 947
Length of demolished roadways	m	250	450	290	390	
Calorific value	MJ/kg	8.74	10.41	8.55	9.63	
Energy from excavation panels	GJ	8 624 982	14 303 184	9 539 868	9 186 914	
Total energy						43 511 687

Parameters at exploitation of the entire area of the south wing of the mine Preloge:

- planned production 4 446 362 tonne
- average calorific value of coal 10.63 GJ per tonne
- planned production of energy 47 264 828 GJ
- required length of constructed lines 7 544 m
- planned production of appliances 196 144 ton
- norm for construction of lines 1.70 m per 1000 tonne



**North wing of the mine Preloge**

Parameters for excavation of exploitation panels at floors G3, G4 and G5 in the north wing of the mine Preloge are shown in Tables 6 to 8:

**Table 6.** Parameters for excavation of exploitation panels at floor G3 in the north wing of the mine Preloge

ET. G3		G3/A	G3/B	G3/C	Total
Excavation panel length	m	294	792	713	1 799
Excavation panel width	m	157	149	195	501
Total roadways	m	1 208	1 890	1 950	5 048
Advancement of development works	m/d	5.0	5.0	5.0	
Production of development works	T	31 408	49 140	50 700	131 248
Advancement of excavation panel	m/d	3.0	3.9	2.8	
Production of excavation panel	t	378 034	942 646	1 138 697	2 459 377
Length of transport routes	m	2 010	1 940	3 180	27 980 204
Length of demolished roadways	m	390	406	535	
Calorific value	MJ/kg	11.57	11.32	11.36	
Energy from excavation panels	GJ	4 373 853	10 670 753	12 935 598	
Total energy					29 473 488

**Table 7.** Parameters for excavation of exploitation panels at floor G4 in the north wing of the mine Preloge

ET. G4		G4/A	G4/B	G4/C	Total
Excavation panel length	m	274	771	706	1 751
Excavation panel width	m	158	150	176	484
Total roadways	m	890	1 920	1 770	4 580
Advancement of development works	m/d	5.0	5.0	5.0	
Production of development works	T	23 140	49 920	46 020	119 080
Advancement of excavation panel	m/d	3.0	3.5	3.0	
Production of excavation panel	t	346 379	927 428	994 172	2 267 979
Length of transport routes	m	2 490	2 600	2 800	25 258 942
Length of demolished roadways	m	280	280	250	
Calorific value	MJ/kg	11.38	11.14	11.05	
Energy from excavation panels	GJ	3 941 793	10 331 548	10 985 601	
Total energy					226 585 292

**Table 8.** Parameters for excavation of exploitation panels at floor G5 in the north wing of the mine Preloge

ET. G5		G5/B	G5/C	Total
Excavation panel length	m	751	691	1 442
Excavation panel width	m	125	177	302
Total roadways	m	1 990	1 870	3 860
Advacement of development works	m/d	5.0	5.0	
Production of development works	T	51 740	48 620	100 360
Advancement of excavation panel	m/d	3.5	3.0	
Production of excavation panel	t	750 310	978 578	1 728 888
Length of transport routes	m	2 500	2 600	18 513 790
Length of demolished roadways	m	290	290	
Calorific value	MJ/kg	10.85	10.60	
Energy from excavation panels	GJ	8 140 864	10 372 927	
Total energy				19 588 639

Parameters at exploitation of the entire area of the south wing of the mine Preloge:

- planned production 9 065 088 tonne
- average calorific value of coal 10.58 GJ per tonne
- planned production of energy 95 908 631 GJ
- required length of constructed lines 22 050 m
- planned production of appliances 573 300 tonne
- norm for construction of lines 2.43 m per 1000 tonne

### Quantities of coal in pillars and abandoned areas

They contain a total of approximately 55 million tonne of coal. It is evident from their location that it will be possible to connect S pillar and the remaining part of G and L panels from the existing main communications for the north wing of the mine Preloge and the hanging wall section of the mine Pesje.

The unexploited part of the mine Škale will be connected from the footline section of the mine Pesje. The location of NOP pillar does not require the construction of new connections - the existing connections can be used for its exploitation.

After finalised exploitation of conceptually treated G area, the remaining

part of G and L panels will be exploited. At the same time, it will be possible to exploit the unexploited part of the mine Škale and S pillar. After finalised exploitation of G and L panels and S pillar, the excavation of NOP pillar will begin and, at the same time, the exploitation in the mine Škale will continue.

In exploitation of the above listed areas, average losses of 10 % to 15 % are expected. Therefore, approximately 49 million tonne of coal can be produced.

### Physical and chemical properties of coal

Physical and chemical properties of coal (shown in Table No. 11) are dealt

with in the expert report »Prediction of physical and mechanical parameters and calorific value of lignite until the year 2028«, expert report No. 02/07-HGS. The properties were researched for exploitation panels according to conceptual solutions listed in the mining project »Exploitation of the mine Pesje from k.-40 to the depression bottom and CD pillar«, project No.: RP-325/007TK and in the expert report »Exploitation of the north wing of the mine Preloge«, expert report No.: TK002/07.

### Total quantities of coal at pre-mogovnik Velenje - situation Dec. 31, 2008

**Table 9.** Balance sheet reserves of coal in the Velenje field of PV

The Velenje field	Reserves (t)
BALANCE SHEET RESERVES (over 8.4 MJ/kg)	171 000 000
BALANCE SHEET RESERVES – A	7 729 050
BALANCE SHEET RESERVES – B	163 270 950

**Table 10.** Excavation reserves of coal in the Velenje field of PV

The Velenje field	Reserves (t)
EXCAVATION RESERVES	131 670 000
EXCAVATION RESERVES – A	6 529 000
EXCAVATION RESERVES – B	125 141 000

**Table 11.** Physical and chemical properties of coal at PV

Physical and chemical properties of coal	
Calorific value	10.47 MJ/kg
Moisture content	35.23 %
Ash content	15.87 %
Sulphur content	1.39 %

## CONCLUSION

Using the confirmed concepts, by using the existing excavation method, a total of approximately 131.67 million tonne of coal can be produced from the Premogovnik Velenje mines situated in Velenje. In calculations of coal reserves of Premogovnik Velenje until the end of exploitation of the Velenje exploitation field, the situation of reserves on 31st December 2008 was taken as a reference point.

It should also be noted that all exploitation concepts have been elaborated on the basis of existing methods for excavation of coal in the mines of PV. Should, in the future, the extraction method change in the sense of reduction of excavation losses, we can predict that it will be possible to produce even more coal at G panels and in CD pillar as planned in the currently valid concepts.

## REFERENCES

- Expert report »Expert report on categorisation, classification and calculation of coal reserves in the area of Velenje coal mine« (situation 31st Dec 1998), Premogovnik Velenje, Technical sector, Velenje, June 1999.
- CERTIFICATE of coal reserves within the exploitation area of Velenje coal mine, situation 31st Dec 1998, Republic of Slovenia, MINISTRY OF ECONOMIC AFFAIRS, Ljubljana, 10th Dec 1999.
- Concession Contract No. 354-13-737/01, Ljubljana, 21st Jan 2002, Concession-granting authority; Authorised person of the Government of the Republic of Slovenia, mag. Janez Kopač, MINISTER OF THE ENVIRONMENT AND SPATIAL PLANNING, Ljubljana, 21st Jan 2002.
- Report »Report on coal reserves on 31st Dec 2004 and comparison with exploitation reserves from long-term exploitation concepts«, Premogovnik Velenje, Technical sector, Velenje, February 2005.
- Expert's report »Report on classification and categorisation of coal reserves and sources on 31st Dec 2008«, Premogovnik Velenje, Expert report No E – 09 – IV, Technical sector, Velenje, december 2009.
- Expert report »Prediction of physical and mechanical parameters and calorific value of lignite until the year 2028«, expert report No. 02/07-HGS, Premogovnik Velenje, Technical sector, Velenje, February 2007.
- Mining project: »Continuation of exploitation in the mine Pesje from k. +40 to k. –40«, RP-13/91, Rudnik lignita Velenje, March 1991, responsible project manager: Marjan Moškon, BSc (Min Eng), revision clause No. 6/25-B/91,

- Mining Institute Ljubljana, 22nd May 1991.
- Mining project: »Continuation of exploitation in the south wing of the mine Preloge until the finalisation of exploitation«, RP-54/91, Rudnik lignita Velenje, August 1993, responsible project manager: mag. Boris Salobir, BSc (Min Eng), revision clause No. 06/28-93, Mining Institute Ljubljana, Ljubljana, 8th Nov 1993.
- Mining project: »Concept of exploitation of the north-western section of the mine Preloge«, Project No. m RP28/91, Rudnik lignita Velenje, February 1995, responsible project manager: mag. Boris Salobir, BSc (Min Eng), revision clause No. 261/95, University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of geo-technology and mining, Ljubljana, 2nd Nov 1995.
- Mining project »Velenje mining method«, Project No: RP-36/95 ML, Rudnik lignita Velenje, Velenje, June 1996, responsible project manager Marijan Lenart, BSc (Min Eng), revision clause No. 297/97, University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of geo-technology and mining, Ljubljana, 16th July 1997.
- Mining project: »Supplementing of the concept of exploitation of the north-western and central section of the mine Preloge«, RP-183/2000 ML, Premogovnik Velenje, July 2000, responsible project manager: Marijan Lenart, BSc (Min Eng), revision clause No. 366/01, University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of geo-technology and mining, Ljubljana, 9th Mar 2001.
- Mining project: »Preparation and exploitation of the panel G1/A«, RP-205/2001ML, Premogovnik Velenje, September 2001, responsible project manager: Marijan Lenart, BSc (Min Eng), revision clause No. KC-12/2001, Ciril Kemperle, s. p., projektiranje, revidiranje in svetovanje, Velenje, 2nd Oct 2001.
- Expert report: »Concept of mine exploitation in the south wing of the mine Preloge and in A pillar in the mine Pesje«, expert report No.: 1/2004BŠ, Premogovnik Velenje, Velenje, March 2004, responsible project manager: Božo Špiegel, BCs (Min Eng).
- Mining project: »Exploitation of the mine Pesje from k.-40 to the depression bottom and CD pillar«, project No.: RP-325/007TK, Premogovnik Velenje, March 2007, responsible project manager: Tomaž Kodrič, BSc (Min Eng), revision clause No. 48/2006, Proteus inženiring biro, d. o. o., Velenje, 6th Apr 2007.
- Expert report: »Exploitation of the north wing of the mine Preloge«, expert report No.: TK002/07, Premogovnik Velenje, June 2007, responsible project manager: Tomaž Kodrič, BSc (Min Eng).