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COAL PRODUCTION IN SERBIA — STATUS AND PERSPECTIVE

1. Introduction

Coal is by far most important Serbian energy potential, with 85% participation in structure of overall primary energy reserves. Several assessments of total coal reserves were performed to date, but due to different assessment criteria and various level of exploration, these assessments yielded unequal results. Reserves Balance from 2005, states that over 76% of total coal reserves was in Kosovo-Metohija basin. Same source provides information that 14% of coal reserves was in Kolubara basin, while 3.3% is in Kostolac basin. Sjenica and Kovin deposits have only 2.7% of total reserves. Also, it can be seen that contribution of lignite within total balanced reserves is around 93%. Most important lignite reserves in Serbia, excluding provinces are in Kolubara and Kostolac basins (including Kovin basin, which is extension of Kostolac basin).

Coal was, is and will be most important source of primary energy in Serbia, regarding both the amounts and energy, regardless to any correction of existing reserves estimations. Largest consumers of coal in Serbia are thermal power plants, with consumption of 96% of total annual production, while remaining part is dried and screened for the industry and open market. Lignite power plants are providing some 60% of total electricity production, while in winter periods, during which demand for electricity is largest, this contribution increases up to 75%.

2. Production of overburden and installed equipment

Coal production at Elektroprivreda Srbije takes place in two basins on five open cast mines (Field B, Field D, Tamnava-West Field and Veliki Crljeni in Kolubara basin and

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Drmno in Kostolac basin), while two open cast mines in Kostolac basin are in closing process (Ćirikovac and Klenovik). Overburden production is around 100 million m³, while the coal production is around 37 million tonnes.

2.1. Production in Kolubara coal basin

Coal production in Kolubara basin takes place in 4 open cast mines Field B, Field D, Tamnava-West Field and Veliki Crljeni. Total annual production is around 70 million cubic meters of overburden and 30 million tonnes of coal. This production is achieved with 17 bucket wheels excavators, one chain excavator, 23 draglines, 15 stackers and self-propelled conveyors and 117 drive stations with some 100 kilometres of conveyors.

Open cast mine Field D. Largest open cast mine, with annual production of around 14 million tonnes of coal and 40 million cubic meters of overburden. Production is organized with 6 excavator-conveyor-stacker systems and two coal systems. Sine mine can not advance toward Vreoci village, part of equipment is engaged on „East kip” dump excavation, as well as in the area of next open cast mine Field E — South wing.

Open cast mine Tamnava — West Field. At the moment production at this field is organized with two excavator-conveyor-stacker systems and three excavator-conveyor-crusher systems. Annual production is around 10 million tonnes of coal and 25 million cubic meters of overburden.

Open cast mine Field B. Currently overburden is excavated with single excavator-conveyor-stacker system (with two benches) engaging two bucket wheel excavators and one coal system with discontinuous excavating equipment. Annual production is around 2 million tonnes of coal and 3 million cubic meters of overburden.

Open cast mine „Veliki Crljeni”. Annual production is around 5 million cubic meters of overburden. Production is organized with one excavator-conveyor-stacker system and one excavator-conveyor-crusher system.

2.2. Production Kostolac coal basin

Current production at Kostolac coal basin takes place in one open cast mine — Drmno, while the Ćirikovac and Klenovik open cast mines are in the closing process (conservation). Overall coal production in 2009 at Kostolac was 8.4 million tones of coal and 32 million cubic meters of overburden. Equipment engaged in production comprises 13 bucket wheel excavators, two chain excavators, 9 drag lines, 13 stackers and self-propelled conveyors and 47 drive stations wit some 35 kilometres of conveyors.

Open cast mine Drmno. Production at Drmno open cast mine is organized with five excavator-conveyor-stacker systems and one excavator-conveyor-crusher system (two parallel faces) engaged on coal excavation.

Excavators engaged at EPS's open cast mines are presented in Table 1, with data on production and operation time during 2009, overall operation time since the start of exploitation and total excavated masses.

TABLE 1

Excavators engaged at EPS's open cast mines

Open cast mine	Annual production (2009)	Excavator	Excavator annual production in 2009	Excavator total production	Operating time in 2009, h	Total operating time, h	Start of operation	Manufacturer
Mining basin Kolubara	Field D 12,705,222 t 29,758,215 m ³	SRs1200.24/4+VR (G4)	4,361,643 [m ³]	210,891,157 [m ³]	5,303	153,157	1975	TAKRAF
		SRs1200.24/4+VR (G5)	4,203,610 [m ³]	194,384,134 [m ³]	5,144	152,681	1976	TAKRAF
		SRs1200.24/4+VR (G6)	4,457,998 [m ³]	197,638,522 [m ³]	5,856	149,549	1976	TAKRAF
		SRs1200.24/4+VR (G3)	5,187,650 [m ³]	230,889,520 [m ³]	5,118	175,772	1968	TAKRAF
			0 [t]	3,541,000 [t]	0	4,100		
		SRs1201.24/4+VR (G2)	5,461,246 [m ³]	189,645,701 [m ³]	5,176	141,896	1968	TAKRAF
		SRs1200.22/2 (G1)	5,824,274 [m ³]	67,868,660 [m ³]	5,160	59,644	1967	TAKRAF
			0 [t]	105,419,550 [t]	0	95,515		
		SchRs1760.32/5 (G9)	0 [m ³]	122,415,537 [m ³]	0	59,817	1990	KRUPP
		SRs1300.26/5+VR (G8)	6,807,887 [t]	143,027,680 [t]	3,878	90,565	1987	TAKRAF
SchRs630.25/6 (G7)	5,843,466 [t]	171,768,221 [t]	3,665	116,601	1977	O&K		
Tammava East + Veliki Crljeni	4,860,991 t 7,799,793 m ³	SchRs900.25/6 (G1)	5,246,817 [m ³]	197,096,806 [m ³]	3,904	126,203	1978	O&K
		SchRs630.25/6 (G2)	4,860,991 [t]	163,056,564 [t]	2,609	99,479	1980	O&K
Tammava West	9,608,567 t 22,394,084 m ³	ERs1000/20 (V1)	0 [m ³]	816,000 [m ³]	0	558	1979	TAKRAF
			2,982,944 [t]	92,892,809 [t]	3,260	61,072		
		SRs2000.32/5+VR (G2)	13,117,727 [m ³]	113,769,899 [m ³]	4,999	53,351	1995	TAKRAF
		SchRs630.25/6 (G4)	7,816,379 [m ³]	60,533,894 [m ³]	5,377	40,718	2000	O&K
		SchRs630.25/6 (G1)	0 [m ³]	4,594,000 [m ³]	0	3,690	1994	O&K
			6,604,773 [t]	82,721,617 [t]	3,946	56,673		
Field B	2,004,036 t 3,880,911 m ³	SchRs C-700s (G3)	3,254,647 [m ³]	37,053,604 [m ³]	3,194	40,019	1987	KRUPP
			0 [t]	15,554,304 [t]	0	18,239		
		SchRs350.12/5 (G4)	510,623 [m ³]	4310193 [m ³]	1,170	13,843	1960	O&K
			0 [t]	27,555,813 [t]	0	71,267		

TABLE 1 Cont.

Open cast mine	Annual production (2009)	Excavator	Excavator annual production in 2009	Excavator total production	Operating time in 2009, h	Total operating time, h	Start of operation	Manufacturer
Mining basin Kostolac	Drmno 8,339,474 t 33,233,566 m ³	SRs470.17/1.5	181,605 [m ³] 1,695,006 [t]	5,014,063 [m ³] 18,695,516 [t]	639 2,458	20,237 38,116	1987	TAKRAF
		SRs2000.28/3+VR	9,090,049 [m ³]	134,976,456 [m ³]	3,618	72,453	1985	TAKRAF
		SRs2000.32/5+VR	10,695,816 [m ³]	91,485,714 [m ³]	4,073	45,181	1997	TAKRAF
		SRs2000.32/5+VR	5,431,190 [m ³]	5,431,190 [m ³]	2,191	2,191	2009	TAKRAF
		SRs1300.26/5+VR	4,997,670 [m ³]	49,021,567 [m ³]	3,991	53,031	1988	TAKRAF
		SchRs800.15/1.5	1,684,304 [t]	41,987,862 [t]	1,674	48,474	1995	O&K
		ERs710.17.5 (J)	2,094,520 [m ³] 0 [t]	34,948,713 [m ³] 1,546,800 [t]	3,576 0	75,004 4,654	1983	TAKRAF
		ERs710.17.5 (U)	0 [m ³] 1,690,479 [t]	2,618,727 [m ³] 18,683,312 [t]	0 4,797	7,275 55,768	1986	TAKRAF
		SRs470.20/3 (12)	742,716 [m ³]	37,345,192 [m ³]	2,971	104,287	1975	TAKRAF
		SRs400.14/1 (14)	0 [m ³] 3,039,751 [t]	13,177,343 [m ³] 10,512,549 [t]	0 3,694	42,694 17,052	1985	TAKRAF
		SRs470.20/3 (11)	786,366 [m ³]	40,607,468 [m ³]	3,394	101,351	1974	TAKRAF
		SRs470.14/2 (3)	218,232 [m ³]	25,963,755 [m ³]	1,171	92,508	1976	TAKRAF
		SRs470.14/2 (4)	61,373 [m ³] 212,625 [t]	17,312,741 [m ³] 8,939,348 [t]	122 530	66,066 17,142	1975	TAKRAF
Čirkovac	260,310 t 1,068,884 m ³	SH630.15/1.5 (8)	0 [m ³] 0 [t]	15,274,478 [m ³] 22,212,306 [t]	0 0	45,923 34,333	1978	O&K
		SchRs300.12/1 (6)	0 [m ³]	4,186,385 * [m ³]	0	61,256*	1959	O&K

* Incomplete data.

As it can be seen, age of bucket wheel excavators is unfavourable (average age is over 25 years) and most of the excavators (especially at the Field D) already achieved 150,000 working hours with excavated more than 200 million cubic meters of material. Therefore, large undertakings can be expected in the future regarding revitalization and modernization of excavators. Some of the equipment transferred from Ćirikovac to Drmno open cast mine was revitalized (excavators SRs 1300, SRs 400 i SRs 470), with scheduled revitalization of remaining excavators.

It should be mentioned that considerable work was performed on equipment modernization at Drmno open cast mine during past several years. Also, assembly of two most recent excavator-conveyor-stacker systems was completed during this year (one at the Tamnava-West field and one at Drmno open cast mine), which will, together with installation of new 2000 mm wide conveyors, improve operating conditions at these mines.

3. Serbian lignite production Development Strategy

Lignite production in Serbia takes place within Public Company Elektroprivreda Srbije. Company defines plans according to framework and goals of Energy policy of Republic of Serbia. Serbian energy development strategy defined priorities and main frameworks of energy policy, while Strategy Achievement Programmes for period 2007–2012 are representing actual Action plans for achievement of the Strategy.

According to the Law on Energy, passed on 2005, Serbian Energy Development Strategy until 2015, which determines long-term development of specific activities, development priorities, sources and means for providing required amounts of energy, incentive measures for investing in energy facilities for use of renewable energy sources, incentive measures for increase of energy efficiency, conditions and means for securing environmental protection etc. This document is basis for implementation of energy policy of Republic of Serbia.

Accepted Strategy for energy development defined growth of energy requirement and electricity generation with increased involvement of domestic energy sources. Energy consumption growth analysis in pending period shows that it is necessary to finalize projects of TE Kolubara B (2×350 MW) and new block TENT B3 (700 MW). One of these with power of 700 MW would supply expected consumption growth, while the other one should replace old, inefficient and ecologically unacceptable blocks. Construction of new capacity is more viable solution in long-term in comparison to investment into environmental protection equipment for inefficient facilities and, therefore, enables more rational management with limited coal resources. Kolubara coal basin has sufficient amounts of coal to sustain such development of electricity generation, backed with appropriate investments, and in accordance with basic principles of sustainable development (energy and ecological efficiency). Also, analyses and expected consumption growth trends as well as potential of generation capacities are showing validity of this approach. Four oldest blocks are scheduled for decommission

until 2015, followed by blocks with power of 200 MW, due to low efficiency and required large investments into their repairs.

Since Serbian energy development strategy was accepted in 2005, major changes happened both internationally and locally. These changes had impact on Serbian energy sector and assumptions for designing its energy future.

Following acceptance of Strategy Serbia became ratified Contract of South Eastern Europe Energy Community. Same contract with EU was accepted by other ten countries from the SEE region, hence accepting liability to harmonize legislations and regulations with those of EU in the field of energy, opening and development of energy market and integration into EU energy market. Application of this Contract is important for JP EPS and Serbia, since it will provide more favourable environment for investors and increased supply security. Investors expect safety for their funds, where one of the most important guaranties is establishment of stable regulatory and legal framework. In relation to this, Strategy should be adapted to these goals, having in mind favourable geopolitical position and transit potential, i.e. take more active role in regional energy sector.

Contract on energy community of SE Europe obliges to monitor energy policy of EU, hence adjustments of national energy policies are necessary with required goals of sustainable energy development. Promotion of sustainable, competitive and secured supply of energy is key assumptions of EU energy policy. After acceptance of our Strategy, EU defined own goals of energy policy until 2020 on January 2008. These are: production of 20% from renewable sources, increased energy efficiency by 20%, reduction of GHG emission by at least 20% and consumption of at least 10% of bio-fuels in total consumption of gasoline and diesel. These targets are referred to data based on year 1990. In order to achieve these goals, coordinated, integrated and regional approach is required, for solving important common energy problems.

Serbian energy sector contributes to gross added value with 5 to 6%. In total import with 17% and in industrial gross added value with 22%. When comparing domestic citizen's living standard with EU countries, in PPS units, domestic GDP per capita is slightly over one third of average of EU countries, i.e. 37% of average in EU-27. Financial crisis impact on EU members was larger in energy sector. Electricity requirements were decreased since the beginning of 2009 for the first time during last ten years.

In case that new generation capacities in the region are contracted and commissioned as planned, expected surplus of electricity in SE Europe region will remain at level of 4–7 TWh until year 2015. However, any delay in investments in new generation capacities will cause shortages in electricity balance and instability of electricity prices on energy markets.

JP EPS is particularly worried by duration of transition period, which is long, and its influence on investments into new planned and/or contracted generation capacities. Especially, since their construction, which did not commenced, have to be in accordance both with existing legislation and with planned local and EU amendments.

Exact procedures for solving climate changes issues are still not defined, and since these are global problem, following their formulation these will become obligatory. Post-

Kyoto mechanisms, for period after 2012, for remediation of climate changes are still far away from agreement. Hence, the cost of CO₂ emission is uncertain. However, one thing is clear, liability to monitor CO₂ emission, which will generate costs resulting in increase of kWh price.

Directive 2008/01/ES on comprehensive prevention and pollution control was passed on beginning of 2008. This directive incorporates LCP, IPPC directive and six sector directives into one, with considerably tighter conditions. Also, directive is now applied on smaller power plants, up to 20 MW. This directive now sets conditions on allowed pollutants emission, which are generated by combustion in thermal power plants, as well as compliance with applied technologies with referent (BREF[8]) BAT-Best Available Techniques, which is time dependant category. Unfortunately, Serbia and JP EPS, is not capable to participate in neither of 32 established work groups at EU countries level and candidate countries level. These groups are thematically monitor BAT technologies and are taking active participation in definitions of new regulations. This means that all our plans related for future constructions must be adjusted with regulations indirectly passed by equipment manufacturers, through their representatives in any of these 32 work groups. Compliancy condition with BREF BAT technologies in reality means that in the moment of beginning of construction of new generation facility and definition of construction contract, JP EPS must „look into future” at least for the period until beginning of production and as precise as possible foresee conditions which plant will have to fulfil at the moment of commissioning, i.e. to foresee further changes in regulations. Without any doubt, any future changes in regulations will cause additional costs, thus directly increasing planned and/or started investment.

Since 2000 numerous activities on renewal, modernization, efficiency improvement and reliability increase of thermal generation facilities were performed. Largest sources for these purposes were from donations in forms of grants and by assigning so called „soft” credits. Conditions for these credits and poor conditions of facilities in power plants dictated that largest portion was directed into revitalization of thermal power plants. This approach created situation in 2006 when electricity generation capabilities overcame coal production capabilities, which potential is used as basis for balancing electricity system. Therefore, this disproportion would be enlarged in the future, without investments in extensions and modernization of existing mining facilities. On the other hand, financial potential of Elektroprivreda Srbije did not enabled to continuation of investment cycle after 1990, with new production capacities and opening of new coal mines, as replacement for depleted ones. Particular problem is that investment cycle in mining is longer, and opening of new open cast mine requires at least 5 to 7 years.

Any investments delay in mining sector after 2012 will result in coal shortages up to 7 to 8 million tones. Common for all mines is that equipment is older than 35 years (except Tamnava West Field) and necessity for equipment revitalization and modernization or replacement with highly automated and more productive equipment, which must be subject of technical and economical analyses. One of the modernization’s basic segments is increased automation of the process, including rational engagement of workers and increased time

and production utilization. Also, maintenance system is out of date, inefficient, expensive and burdened with large number of workers, hence it is urgent to perform rationalization and modernization of the maintenance equipment and process.

Consequence and large problem of long term lack of action for modern society with institutions responsible for construction of residential objects and infrastructure is expropriation and unapproved construction. Issue of Vreoci village relocation threatens production at open cast mines Field D and Veliki Crljeni. Lignite production forecast up to year 2020 is shown on Figure 1.

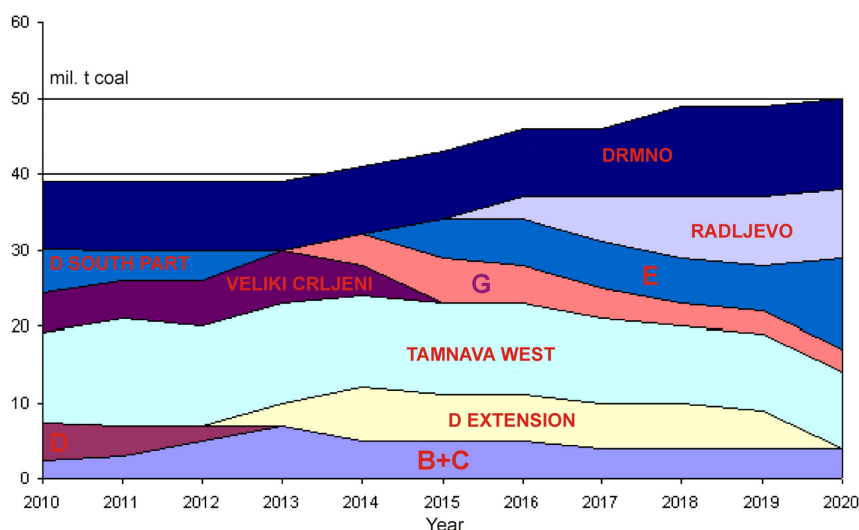


Fig. 1. Lignite production forecast in Serbia until year 2020

3.1. Coal development strategy at Kostolac basin

Coal from Kostolac coal basin is mainly used in thermal power plants, while smaller amounts are supplied to the open market. Continuous operation of four blocks in power plant, with total installed power of 1000 MW, including some 500.000 t of lump size coal for the open market, demands supply from the open cast mines at level of 9×10^6 t of coal annually. Assembly completion of fifth excavator-conveyor-stacker system creates conditions for achieving this production rate.

According to Concept project with Feasibility study of Development Completion of PK Drmno for designed capacity of 6.5×10^6 tonnes of coal per year and production increase up to 9×10^6 tonnes of coal per year, coal production dynamics and development of electricity generation facilities in Kostolac includes operation of TPP Kostolac A up to year 2024, followed by its decommission and construction of replacement facility TPP Kostolac C.

According to Innovated long-term development programme of coal production in Kostolac coal basin (RGF,2006) further production rate increase is planned on single open cast mine Drmno, for additional 3 million tonnes of coal annually. In this way production at this mine will reach level of 12 million tonnes of coal per year. This creates conditions for construction of additional thermal capacity with power of 350 MW. Continuous operation of planned electricity generation facilities with annual coal production of 12 million tonnes during foreseen operation period requires 436.5 million tonnes of coal.

Single critical issue in completion of this project is dynamics and efficiency of drainage system at Drmno open cast mine. Also, development of additional investment and technical documentation is urgent, including efficient acquisition and assembly of basic equipment and auxiliary infrastructure objects.

3.2. Coal development strategy at Kolubara basin

Largest energy producer within Elektroprivreda Srbije is PD Termoelektrane Nikola Tesla, with installed power of 3,285,6 MW. Only supplier of coal to these power plants is PD RB Kolubara, with annual production of coal at level around 30×10^6 tonnes. Dependant on the requirements and capabilities, thermal power plants Nikola Tesla, during period 1990–2005, generated 16,000 GWh annually on average, while the average production during last three years was 19,400 GWh.

Coal production at PD Kolubara, with difficulties, followed requirements of thermal power plants thus enabling regular electricity generation. Electricity generation growth at Nikola Tesla power plants (some blocks were revitalized and their power was increased) should be backed by coal production increase at Kolubara mining basin, including opening of new open cast mines.

Current development of mines is in sensitive situation, where some mines are approaching closure, while the other are not capable to achieve maximal designed annual coal production. Also, there are uncertainties regarding opening of new and replacing capacities. Adjusting development dynamics of open cast mines should provide safe supply and coal production for the power plants, thus providing safety to the electricity system.

Dynamics forecast on overburden and coal production included coal beneath cemetery in Vreoci village, and coal at south part of Field D, i.e. operational life extension of Field D. It is necessary to commence development of Long-term development programme of coal surface mining in Kolubara basin during this year.

Having in mind results of later studies, given in Updated investment programme for construction of Tamnava West Field open cast mine and Concept study with Feasibility study on reopening and construction of Field E open cast mine, as well as accepted solution given in Study on boundaries selection and opening of Radljevo and South Field open cast mines, planned and updated general dynamics of coal production in Kolubara basin until 2020 is shown in Table 2.

TABLE 2
Coal production forecast at Kolubara basin until year 2020 (in million tonnes)

Year	Field B + C	Field D	Extension Field D	Tamnava West	Veliki Crljeni	South Field G	South Wing Field E	Radljevo	Total
2010	2.4	5.0		11.9	5.0		5.8		30.1
2011	3.0	4.0		14.0	5.0		4.0		30.0
2012	5.0	2.0		13.0	6.0		4.0		30.0
2013	7.0		3.0	13.0	7.0				30.0
2014	5.0		7.0	12.0	4.0	4.0			31.0
2015	5.0		6.0	12.0		6.0	5.0		34.0
2016	5.0		6.0	12.0		5.0	6.0	3.0	37.0
2017	4.0		6.0	11.0		4.0	6.0	6.0	37.0
2018	4.0		6.0	10.0		3.0	6.0	8.0	37.0
2019	4.0		5.0	10.0		3.0	6.0	9.0	37.0
2020	4.0			10.0		3.0	12.0	9.0	38.0
Total	48.4	11.0	38.0	128.8	27.0	28.0	54.8	35.0	371.1

Coal production forecast at RB Kolubara until year 2020 have problems generated not only with long-term delays in development of surface mining, but also by required work on designing and necessary exploration, required for proper designing process. Particular issue is lack of proper planning documentation.

Therefore, it is necessary to perform faster and more efficient preparations for opening of new open cast mines in period 2010–2015, in order to provide required coal. Planned start of coal production on new open cast mines is:

- Field G — year 2014;
- Field E — year 2015;
- Radljevo — year 2015.

Field Radljevo should be start coal production on 2015. Complex deposit structure and bands of clay series of small thickness, are requiring acquisition of distribution stations. Also, opening of mine requires partial relocation of Radljevo, Kalenić, Šarbane and Brgule settlements, relocation of Kalenić-Radjjevo road, solving relocation of river Kladnica with affluents and, of course, large overall investments, estimated at 1.233 million euro. During opening of the mine, overburden will be dumped into internal dumps at Tamnava East Field and Tamnava West Field.

Tamnava South Field includes geological field F and G. Coal is located in first and second seam, with reserves over 350 million tonnes. Unfavourable seam dipping, large depth, high level of ground water and proximity of railway Belgrade-Bar and other infrastructure are representing considerable limitations for exploitation of this deposit. Therefore, it should be considered possibility to open Field F from the eastern part, from Field D and Field E. Calculation of overburden and coal was performed for limited area of the open cast mine. Anyhow, phase coal mining at Field G should start on 2014, due to lower overburden coefficient. It is necessary to dislocate rivers Kolubara, Lukavica and Peštan in phases, before opening of the mine. Also, Ibarska magistrala road (M-22) should be relocated. Pre-drainage of overburden is necessary for operation of excavator-conveyor-stacker system, before opening of the mine, as well as cleaning of previously active river beds from alluvium and waste.

Field E is replacement capacity for Field D. Initial geological explorations provided interpretation on tectonic fault along southern border of Field D. Additional exploration confirmed continuity of the seam with syncline dipping of main seam (II) and appearance of first seam in parts of Field E. Having in mind new mining dynamics and extension of Field D due south, it can be reliably stated that opening of Field E will be performed by existing equipment engaged on Field D and extended mine Field C. Opening system is more complex, regarding dipping of the main coal seam, since floor of the main seam must be excavated, beside the overburden and inter seam waste, in order to provide stability of easter and northern zones of the mining field. Relocation of Peštan river is in long-term plan, as well as Baroševac-Arandelovac road. Particular importance have stabilization of internal waste dump at Field B and Field C, before opening of open cast mined Field E,

since this mining area will be used as external waste dump during opening of Field E. Overburden mining should start on 2012, with equipment from Field D. Having in mind importance of this mine, complexity of the deposit, dumping dynamics, insufficient knowledge of hydro-geology, together with relatively low of total investments, estimated at 303.5 million euro, and according to Annexes to Updated investment programme from 2008, it is necessary to commence development of updated technical and economical design documentation in time. Special attention should be given to solution of river Peštan relocation, which must be completed until 2012.

TABLE 3
Planned investments

Position	Total investments (mil. euro)	Until 2015 (mil. euro)
Revitalization of equipment at RB Kolubara	25,9	25,9
PK Tamnava West field	228,7	228,7
Polja D extension in Vreoci zone	220,2	220,2
Polja B extension in Field C	180,6	180,6
PK Veliki Crljeni	63,9	63,9
PK Polje E (replacement for Field D)	639,5	387,4
Kolubara, PK Radljevo	1 403,0	611,5
PK Drmno	200,0	150,0

Financing of such large scale development plans is possible only by combined sources, as:

- Strategic partnerships, mainly in urgent production capacities (PK Radljevo);
- Favourable credit arrangement, with State as a guarantee;
- Changes in electricity price policy, which at this moment is not sufficient even for financing environmental projects.

Negotiations with Government of China are taking place at the moment, related for credits on revitalization of existing blocks and construction of new thermal facility in Kostolac. Resources in Kolubara and Kostolac basins are sufficient, and of proper quality, to support, with proper investments, such development trends of electricity generation, which is in accordance with basic principles of sustainable development (energy and ecological efficient).

Development of such projects requires long-term and complex preparation activities, where large part of these activities is related to securing required amount of fuel, namely coal. Opening of replacement capacities also requires additional equipment for mining, haulage and stacking.

4. Precondition for completion of planned investments

Along solving of above mentioned problems, basic precondition for completion of planned investments is provision of financial sources. Plan for JP EPS includes over 9 billion euro until year 2015. JP EPS can provide 3.4 billion euro from own sources, additional 3.8 billion euro can be provided from credits and expected credits, another 1.8 billion euro will be provided by participation of strategic partners, while remaining 0.2 billion euro would be provided from donations, consumers and ecological tax.

Simultaneous increase of electricity price is required, to the level which enables economically acceptable business. Assumed price increase until 2012 is at least 8 euro cent/kWh, reaching 10 euro cent/kWh until 2015. Also, reduction of losses in distribution network are foreseen, which are currently are at unacceptable level of 15%, as well as increase collection of debts. For efficient reduction of losses in JP EPS, especially non-technical ones — steels, support and determination of state institutions is required, since only joint action of JP EPS, police and judicial institutions can successfully, efficiently and permanently solve this problem.

JP EPS was treated as an institution for solving social issues for a long period, causing the price of electricity to be low, below level required for successful business, while fuels price correlation were not solved. Last year Government passed document important for JP PES — Action plan for protection of socially threaten consumers of electricity. Idea of the document is to relocate support to this group from the JP EPS. Energy agency developed Comparative analyses for protection of threaten consumers in some countries and forward it to Ministry of work RoS. Swift implementation of this document is of huge importance for JP EPS as a company, since it would create precondition for economically acceptable business.

5. Conclusion

Some 90% of overall annual coal production in Serbia is used for electricity generation, therefore coal mining development, especially surface mining of lignite, is connected to planning and forecasts of electricity generation and consumption in Serbia.

Dependence of energy, economy and ecology is crucial factor for development of modern technologies. Population increase, better life quality and standard, industry and traffic development, including increased impact of energy production and consumption at the environment, resulted in increased energy demand. Analyses performed at EPS showed that planned overall consumption of electricity in Serbia until 2025 will increase by 1% annually. A shortage of electricity is present in the region including Serbia and it shows that absence of new production capacities threatens to endanger supply safety. This conclusion is gaining on importance if closure of old, inefficient and small thermal blocks is considered, which are also significant polluters of the environment.

Coal has long term perspective and competitive position for electricity generation in Serbia, as cheapest domestic primary fuel. Moderate increase of electricity price in long

period was result of utilization of coal as primary fuel in Serbia. Until 2020 focus will be on lignite production equipment revitalization and efficiency increase, introduction of equipment for coal homogenization and supply of coal with declared quality, as well as on modernization of existing and construction of new thermal power plants, thus improving energy efficiency.

Larger electricity generation with reduction of SO₂ emission is a task to be overcome by producers of electricity in power plants, but also by coal producers on open cast mines. This task is a consequence tighter demands of EU and World, must be included into strategy of Elektroprivreda Srbije in immediate future.

Achievement of these plans on coal production increase to 48 million tonnes annually at EPS, requires large investments into mining equipment. Beside acquisition of new equipment it is necessary to perform revitalization and modernization of existing mechanization. Also, maintenance system must be reorganized, while production efficiency must be improved by larger time and production utilization.

Anyhow, energy sector represents key challenge for national, ecological and economical progress. By exclusive approach to domestic deposits, lignite industry is a warrant for reliable fuel, and can provide long term supply based on proved reserves.

REFERENCES

- [1] „JP EPS plan rada i razvoja 2008–2015”, 24.7.2008
- [2] „Zakon o ratifikaciji Ugovora o osnivanju Energetske Zajednice Jugoistočne Evrope”, Sl. glasnik RS br.62/2006
- [3] „An Energy Policy for Europe”, Communication from the European Commission, 10 January 2007
- [4] Direktiva 2008/01/ES o sveobuhvatnom sprečavanju i kontroli zagađenja (LCP-BREF), „Integrated Pollution Prevention and Control Directive”, 15.01.2008
- [5] „Large Combustion plants Directive 2001/80/EC”, 23.10.2001
- [6] Akcioni plan za zaštitu socijalno ugroženih potrošača električne energije, Vlada Republike Srbije, 2010
- [7] *Kolnja B., Ignjatović D., Mitrović S., Jakovljević M., Radovanović V.*: Program ostvarivanja strategije energetskog razvoja Republike Srbije do 2015 godine — modul rudnici sa površinskom eksploatacijom. Zbornik radova „Energetika 2010“, Zlatibor 2010
- [8] *Mitrović S., Milosavljević J.*: Novi investicioni ciklus u energetici Republike Srbije i ograničenja u njegovoj realizaciji; viii međunarodni simpozijum Mehanizacija i automatizacija u rudarstvu i energetika MAREN 2010, Univerzitet u Beogradu — Rudarsko-geološki fakultet, Lazarevac, Zbornik radova, COBISS.SR-ID 175997964
- [9] *Pavlović V., Čeran N., Radovanović V., Jakovljević M.*: Strategija razvoja rudarskog basena Kolubara; viii međunarodni simpozijum Mehanizacija i automatizacija u rudarstvu i energetika MAREN 2010, Univerzitet u Beogradu — Rudarsko-geološki fakultet, Lazarevac, Zbornik radova, COBISS.SR-ID 175997964
- [10] *Ignjatović D., Jakovljević M.*: Proizvodnja uglja u Srbiji — primena i stanje mehanizacije; viii međunarodni simpozijum Mehanizacija i automatizacija u rudarstvu i energetika MAREN 2010, Univerzitet u Beogradu — Rudarsko-geološki fakultet, Lazarevac, Zbornik radova, COBISS.SR-ID 175997964