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Air Pollution with Particulate Matter and Heavy Metals of Kosova Thermal Power Plant[#]

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Abstract: Kosova is a mountainous farm region which at past was in the process of industrialization because of its reach coal and mineral resources. The problem of air pollution in the surroundings of Power Plants appeared as early as 1954 when Thermal Power Plant of Kosova has started work in Obiliq. The city of Obiliq, approximately 5 km north of Prishtina-capital of Kosova, is the site of one the largest air pollution. Coal - related industries have been a major element of the economy of Kosova, but created extensive health risk due to environmental pollution with PM and a variety of other substances. Electricity in Kosova is produced by two lignite-fired TPP (Thermal Power Plant) "Kosova A" - (five units) and "Kosova B" - (two units), with total installed generation capacity of 1,513 MW. Most of the units of the two thermal plants are in poor operating conditions so that the present available capacity of the system is only 841 MW. The combustion process leads to the generation of emissions to air, water and soil, of which emissions to the atmosphere are considered to be one of the main environment concerns. The most important emissions to air from the combustion of fossil fuels are SO_2, NOx, particulate matter (PM), heavy metals and greenhouse gases such as CO_2. The problem with dust emissions is serious and apparently cannot be solved without major redesign of the boilers. Ash from the both power plants is currently transported by open belt conveyors and is deposited at dumpsites. No environmental protection measures in the dumpsites are taken to prevent ash spreading by wind. Deposition of ash in dumpsites must stop as soon as possible and instead use ash for backfilling of mined parts of the lignite mines. Closed belt conveyors should be used to prevent spreading of fine dust particles during transportation of ash.

Keywords: *Fossil fuels, heavy metals, particulate matter*

Introduction

The first electric energy production facilities of KEK were constructed in year 1962 and the last one was constructed in 1984 [Table 1]. Existing KEK Power Plants, gasification and heating plant are using large lignite reserves of Kosova.

KEK used to provide the following services:

- Raw coal for power plants and for the local market.
- Dried coal for the market (industry, households, in the past for production of synthetic gas).
- Production of electric energy in the thermal and hydropower plants as well as technological steam produced in industrial heating plant.
- Production of medium quality synthetic gas from the dried lignite.
- Production of artificial fertilizers (out of function).
- Transmission and distribution of electric energy.

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In the period between 1962 and 2001 some 115 TWh of electric energy was produced by KEK where 45% was exported. Balance of electric energy production is shown in Figure 1, were it can be clearly seen that up to year 1999 Kosova was net electricity exporter.

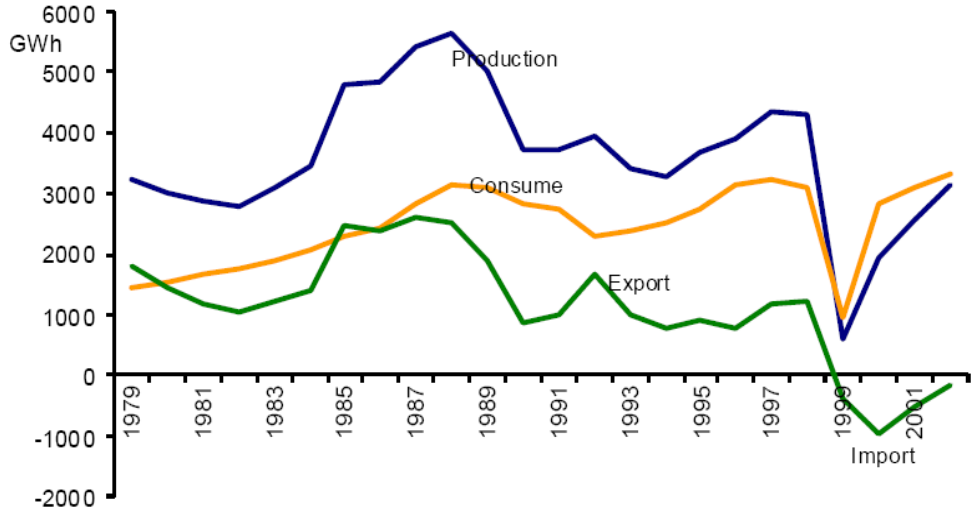

Figure 1. Balance of production, consume and energy exchange for period 1979-2001

Generation

Electricity in Kosova is produced by two lignite-fired TPP "Kosova A" and "Kosova B" with total installed generation capacity of 1,513 MW [Table 1]. Most of the units of the two thermal plants are in poor operating conditions so that the present available capacity of the system is only 841 MW. Overhauling and rehabilitation works have been carried out or are underway on most of the units. The total production in 2000 was 1,914 GWh and rise to 2,568 GWh in 2001.

Table 1. Existing generation facilities in Kosova

Power Plant	Unit	Installed Power [MWh]	NET Power [MWh]	NET Available Power [MWh]	Fuel	Start of operation
Kosova A	A1	65	58	30-40	L/N	1962
	A2	125	113	0	L/N	1964
	A3	200	182	130-145	L/N	1970
	A4	200	182	120-145	L/N	1971
	A5	210	187	135-150	L/N	1975
Kosova B	B1	339	309	230-250	L/M	1983
	B2	339	309	230-250	L/M	1984

L/N – Lignite/Naphtha, M – Mazoute

Lignite is of outstanding importance to electricity generation in Kosova. It contributes to 97% of the total electricity generation, 3% being hydro based power generation. Considering all the potential sources for power generation in Kosova coal safely maintains its leading position.

The Kosova lignite mines are operated at one of the most favorable lignite deposits in Europe due to its geological conditions. With an average stripping ratio of 1.7 m^3 of waste to 1 ton of coal, coal production at Kosova mines could supply very competitive fuel to the power plants, compared to international fuel sources and energy prices. The total estimated economically exploited resources of approximately 10,000 Mt represent one of the richest lignite sources in

Europe, which would allow ambitious power generation and expansion schemes in the forth coming decades. Coal supply can rise in correlation with increasing electricity consumption. Coal can be supplied with the highest degree of security and with predictable price levels. By this, Kosova can take advantage of its large reserves and of its location in centre of South East Europe, where lack of electricity is to be expected in the mid to long term period.

Environmental issues of power generation

Combustion installations within large thermal power plants use large amounts of fossil fuels and other raw material taken from the earth's natural resources and convert them into useful energy. The combustion process leads to the generation of emissions to air, water and soil, of which emissions to the atmosphere are considered to be one of the main environment concerns. The most important emissions to air from the combustion of fossil fuels are SO_2, NOx, particulate matter (PM), heavy metals and greenhouse gases such as CO_2.

Coal reserves

There are two major lignite basins: "Kosova**"** lignite basin and "Dukagjini**"** lignite basin and also smaller lignite basins like: "Drenica, Malishevë, Babush i Muhaxherëve**".** Lignite basin and one potential lignite basin in southern part of Kosova are given in Figure 2. The lignite of the Kosova basin belongs to the upper Miocene and has an age of about 9 million years. The coal seam thickness varies between 56 m and 70 m. The original overburden coverage shows a thickness of 60-120 m. Kosova has the total estimated resources of approximately 10,000 Mt.

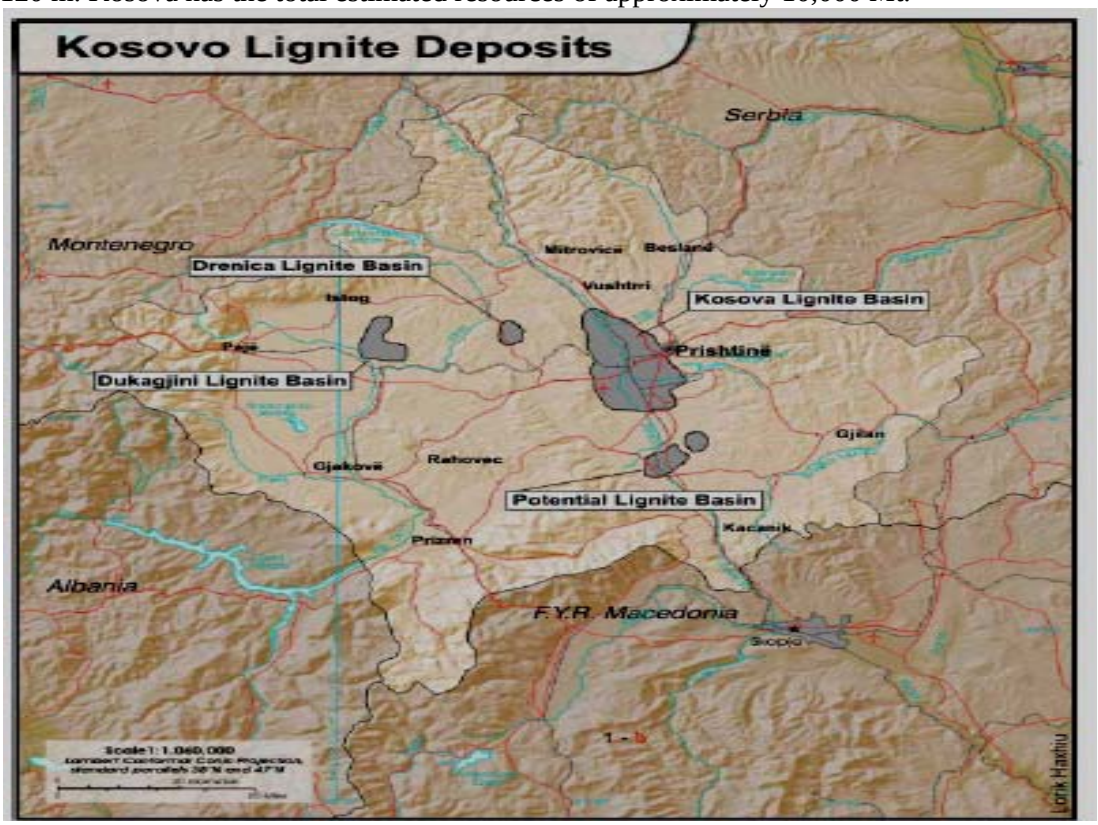

Figure 2. Kosova lignite basins

Coal quality

The average values of lignite quality parameters of the different mine areas are:
Moisture content: vary between 35% and 50%; Ash contents: between 12% and 21% within the coal seam. The average values are around 14% to 17%; Heating values: 7800 kJ/kg on average in the Bardh-Mirash area, while 8100 kJ/kg in the Sibovc area; Sulphur: 1% in all parts of the mines/deposit including an average content of combustible sulphur of 0.35%; Lime: Lime concentration is sufficient to absorb significant amount of SOx during combustion so that desulphurization of flue gases is not required.

Power plant Kosova A

The problem with dust emissions is serious and apparently cannot be solved without major redesign of the boilers. An assessment of possible reduction in dust emission shows that the A units w ill not comply with current EU regulations even after recommended actions are taken. Units in Kosova A are already at the end of their lifespan and further investment in these units may be questionable.

Power Plant Kosova B

Considering that the remaining lifetime of B units is quite long, harmful effect of fine dust particles on human health, bad operation of existing electrostatic precipitators and relatively low costs of dust control equipment the rehabilitation of filters is proposed in years 2006 and 2008. Additionally harmonization with EU NOx emission standards is planned on units B. The nitrogen oxides emission concentrations are in range of 600 - 950 mg/Nm3. From environmental point of view it is better to reduce higher B2's NOx emissions at first. In projection this w ill be carried out in the year 2008. On B1 the same intervention will take place in the year 2016. On units A no further investments in NOx control equipment is planned.

Ash dumps

Ash from the both power plants is currently transported by open belt conveyors and is deposited at dumpsites. No environmental protection measures in the dumpsites are taken to prevent ash spreading by wind. Deposition of ash in dumpsites must stop as soon as possible and instead use ash for backfilling of mined parts of the lignite mines. Closed belt conveyors should be used to prevent spreading of fine dust particles during transportation of ash.

Environmental impacts of mining operations

The review of the impact of the mining operation on the environment has been carried out considering past damages and future effects of the mining operation. Measures to minimize the future effects of the mining operation like dust and noise emissions, water pollution and resettlements have been planned. With respect to the past damages, two main areas of concern have been identified, the recultivation of the old outside dumps and the extinguishing of smouldering mine fires. The recultivation of the outside dumps can be carried out at reasonable efforts and costs. How ever, special intention must be paid to the mine fires, which cause environmental problems (air pollution), safety problems in the mines and an economic damage on the deposit.

Air particulate sampling

A primary pathway for human health exposure to heavy metals is inhalation of air particulates containing heavy metals. Air particulate samples were collected in the some problematic sites of Kosova TPP that are in the vicinity of the industrial sources area.

The primary air sampling program utilized battery powered 24-hour volume samples through 37 mm quartz filters. Sampling with these samples was conducted at 8 locations areas in surrounding of Kosova TPP.

An inlet designed for measurement of total suspended particulate was used rather than a size selective inlet, since the total loading of heavy metals was of most concern, rather than the respirable or ”PM10” fractions. The 37mm filter samples were pre-and post-weighed to determine Total Suspended Particulates (TSP) concentrations and analyzed to determine airborne lead and selected heavy metal concentrations. Air sampling averages at the primary air monitoring sites are summarized in Table 2 and Figure 3.

Table 2. Concentration of particulate matter (PM) in some monitoring sites

Annual average of PM during the year 2005				
		Concentration [µg/m^3]		
No.	Monitoring sites	TSP	PM10	PM2.5
1	Milloshevë- Muzakaj	190.29	62.83	14.54
2	Kosova "B"- Plemetin	114.34	25.85	11.87
3	Deponia_TC "A"	196.67	88.73	18.36
4	Dardhishtë	194.16	86.09	17.88
5	MS Bardh	102.26	59.19	21.94
6	Obiliq i vjetër	111.99	61.86	18.24
7	Sh. Transportues - Hade	381.51	193.29	19.65
8	Fushë Kosovë	288.05	132.04	20.18
EU Standards (annual)		80	40	15 (EPA)

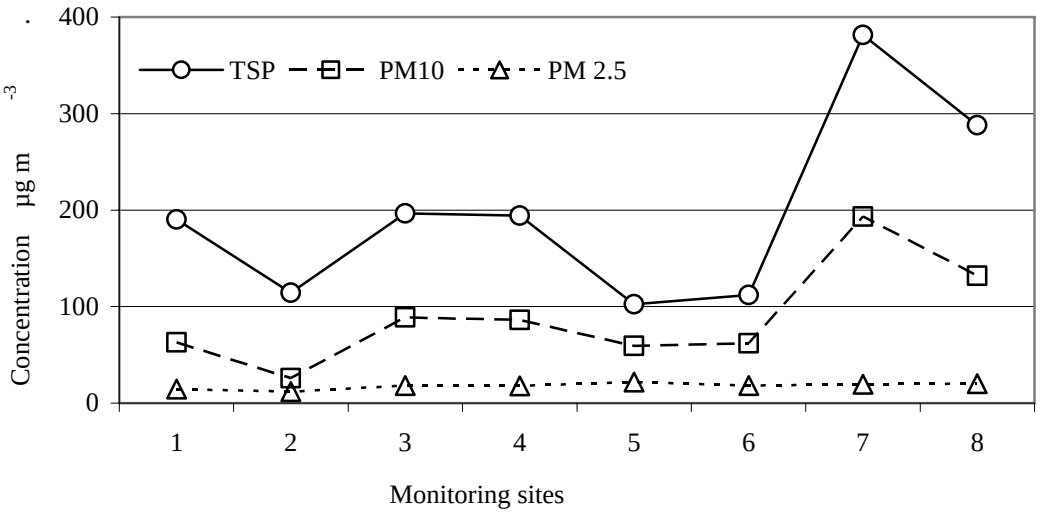

Figure 3. Diagram of particulate matter in monitoring sites

Granule composition of ash

Ash is a tiny dust with composition of tinier particles of 0.071 mm, from 60 to 99%. Participation of bigger particles (tinier than 1mm, whereas bigger than 0.5) is small and comes around 0.5 to 2.9%. Slag is massive; participation of tiny particles of 0.104 mm is about 2%, whereas higher granules of 1mm are 30 to 55%. The average of granule diameter to mixture of ash and slag is 0.1mm.

Ash chemical composition

In the ash and slag composition dominates components as: CaO and SiO_2. Average report of measures between these two components into the ash is about 1:1 to 1.4:1. Participation of CaO differs form 28 to 39%, whereas SiO_2 from 27 to 33%. SiO_2 and CaO are dominating components in the chemical link of slag, exception that the report is approximately 4:1. SiO_2 participation differs from 57-64%, whereas CaO from 11-17%. Other component participation of ash silicate analyze in dependence. CaO active participation (free) in the ash differs of 7-9% whereas in slag from 1.7 to 2.2. In tables 3, 4 and 5 are presented the analyses of some samples such as ash, slag and heavy metals in ash, and these also are showed in diagrams in figures 4, 5 and 6.

Table 3. Ash samples in old dumpsite of TC "A"

Ash samples - Year 2006	Old disposal of TC "A" Concentration [µg/g]	
No. of samples	Zn	Pb
I	63	47
II	60	49
III	52	43
IV	58	53
V	49	41

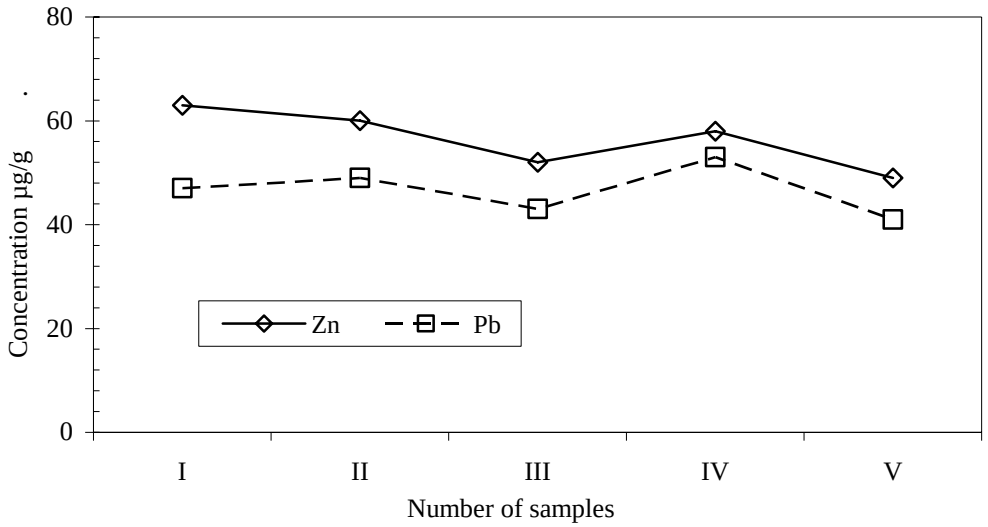

Figure 4. Ash samples from old disposal of TC "Kosova A"

Table 4. Analysis of slag of TC "A"

Slag analysis - 2006	
Components	Percentage
CaO	42.31%
SiO_2	27.22%
Al_2O_3	5.18%
Fe_2O_3	6.93%
MgO	3.42%
MnO	0.16%

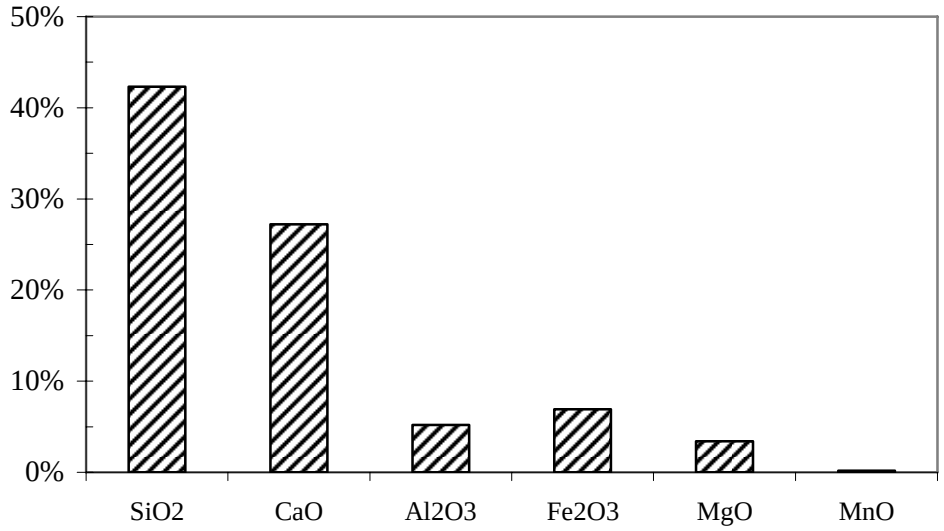

Figure 5. Slag analyses from TC Kosova "A" - 2006

Table 5. Concentration of heavy metals in ash

Heavy metals in ash - 2005 Concentration [mg/kg]		
No.	Zn	Pb
1	0.317	0.002
2	0.293	0.031
3	0.325	0.029
4	0.287	0.024

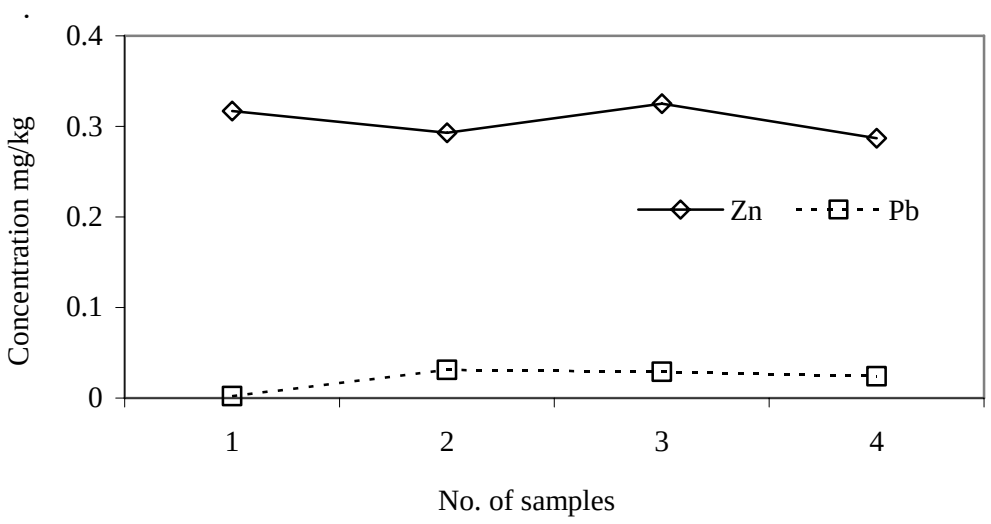

Figure 6. Heavy metals in ash - 2005

Conclusions

Air quality investigation in surrounding of TPP area has shown that the annual PM mass concentrations, in comparison with European Standards are significantly higher. The main sources of suspended particles are combustion of coal in TPP, traffic, tailings, local heating and dust re-suspension. Project and investigation are in progress.

The obtained results and further investigations will substantially improve our knowledge in estimating parameters that define transport distribution and interaction of pollutants from the sources of pollution to human population and are aimed for finding effective solutions to improve air quality and for a sustainable development in urban areas.

The overall lead and zinc content are found in the PM fraction and in the ash. It was significant correlation between lead and zinc concentrations. While seasonal trend of lead concentrations is obvious, showing elevated concentrations during autumn-winter period, no such trend for cadmium concentrations could be determined

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