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PROJEKCIJA EMISIJE SO₂ U TERMOELEKTRANAMA NA UGALJ U SRBIJI

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PROJECTION OF SO₂ EMISSIONS IN COAL POWER PLANTS IN SERBIA

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Abstract: *The production of electricity in the countries of South-Eastern Europe (SEE) was mainly related to the use of coal, predominantly lignite. The total installed capacity of thermal power plants using coal in these seven countries is 17.813 MW, distributed in 31 thermoblocks. The mentioned plants are the dominant pollutant emitters in all observed countries. Data on the largest emitters in the countries of the European Union and a comparison with SEE countries were collected. The calculation of emissions of SO₂ for two thermoblocks of the thermal power plant Kostolac, Serbia was carried out. Comparisons were made with the emitters from EU countries with a special focus on SEE countries. The projections of future SO₂ emissions from new wells in parts of surface mining intended for exploitation was given.*

Keywords: *energy, emissions, SO₂, coal, power plants*

1. INTRODUCTION

Reducing emissions of pollutants and gases from coal-fired thermal power plants has always been a must. Coal production in Europe is steadily declining. In 2010, it was 835 Mt to 516 Mt in 2021. Recent events of a political and economic nature on the soil of Europe have influenced the intensity of the change in energy sources, so the process of removing coal from electricity generation has greatly intensified. In 2021, for the first time in the area of the European Union, more electricity was generated using solar and wind energy than coal. The idea of using the cleanest technologies has completely changed the direction of energy development in the EU [1].

The largest coal producing countries in 2021 on the territory of Europe are Germany, Poland and Serbia, but without Turkey. Southeastern Europe (SEE) where Serbia is located, along with Germany and Poland, are the largest producers of solid fuels in Europe. 130 of Thermal power plants are in Germany, Poland and SEE region. The dominant fuel for electricity production is still coal. Europe has 243 active coal-fired power plants, with 600 blocks, and 147477 MW of an installed capacity. These capacities supplied 16% of the electricity to Europe of the total electricity generated in last year [1, 2].

Table 1 shows the basic characteristics related to electricity production in Germany, Poland and Serbia (population, total installed capacity, installed capacity from coal, gross electricity production, electricity production from coal, electricity production per capita) [1-9].

There are 42 coal-fired thermal power plants in Poland, while 57 are active in Germany. The installed capacity, structure of power plants and coal production are shown in Table 1 [1, 4, 10].

Table 1. Installed capacity, structure of power plants and coal production

Country	Capacity (MW)	Power plants / Units	Production of coal (Mt)
Germany	39669	57 / 106	126
Poland	28698	42 / 138	107,6
SEE	17813	31 / 99	78,3
Serbia	4400	6 / 17	36,4

The Southeast Europe is characterized with old coal power plants, 31 active 31 coal-fired thermal power plants with 17813 MW of installed capacity. The thermal energy capacities of the Republic of Serbia consist of six thermal power plants, with 17 active thermo-blocks, with a total installed capacity of 4400 MW, which exclusively use lignite and three thermal power plants-heating plants, with a capacity of 403 MW for the production of electricity and 505 MW for the production of thermal energy, divided into 6 blocks, on liquid and gaseous fuels [10].

Figure 1 shows the SEE region with thermal power plant's locations in BiH, Romania, Bulgaria, North Macedonia, Greece and Serbia.

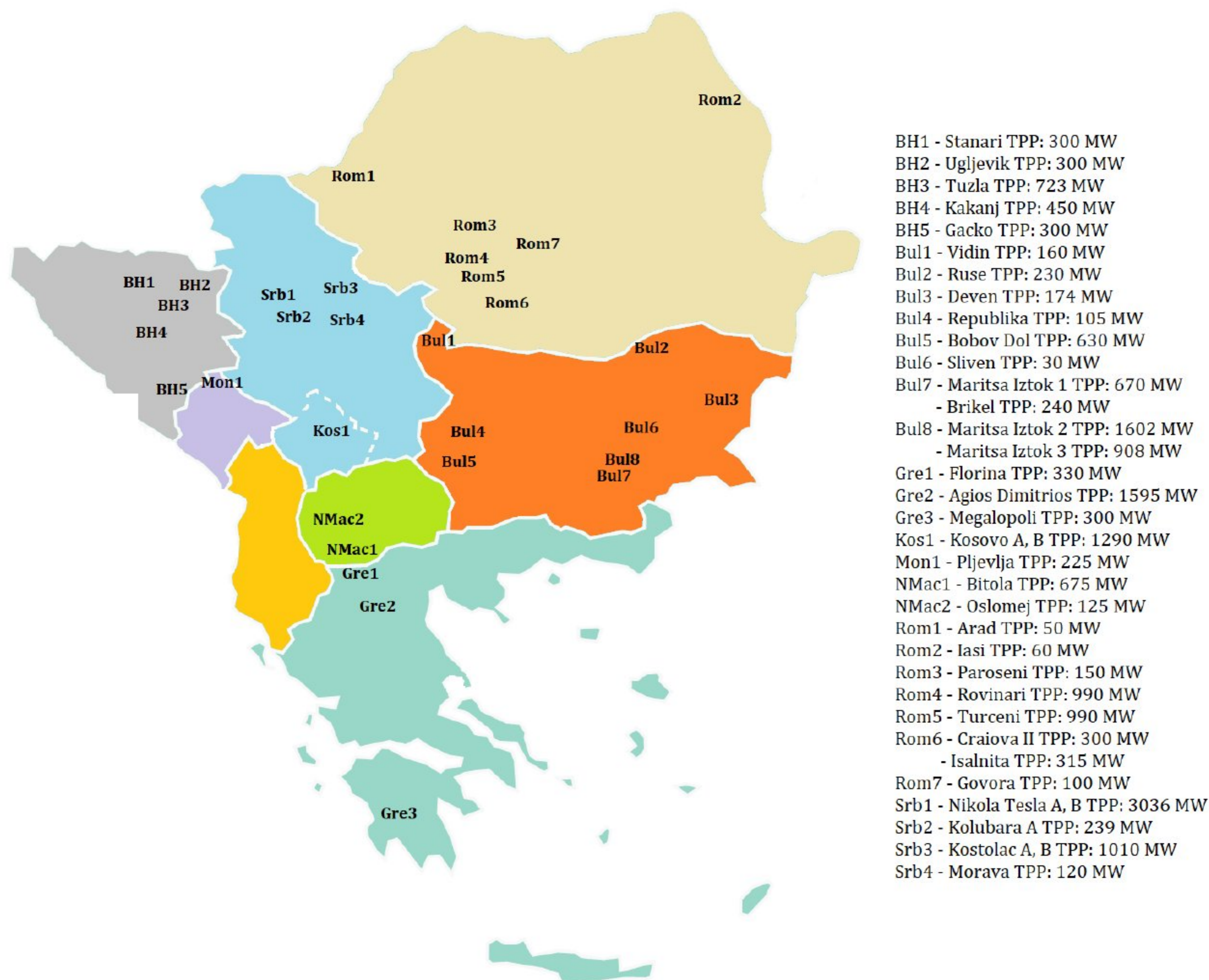


Figure 1. Region SEE with thermal power plant's locations

2. SO₂ EMISSION IN EUROPE AND SERBIA

Tables 2 show thermal power plants in Europe that are the biggest emitters of SO₂. Therefore, the coal-fired thermal power plants of the SEE region represent the biggest polluter in Europe (excluding Turkey and Ukraine) [11].

Table 2. Top 5 emitters SO₂ by Europe in 2021 [11, 12, 13]

	Power plant	Country	SO ₂ emissions [kt]	Coal	Installed power [MW]	Generation [TWh]	Relation [ktSO ₂ /TWh]
1.	Nikola Tesla	Serbia	167.9	Lignite	3036	14,32	11,72
2.	Bitola	North Macedonia	105,4	Lignite	675	1,86	56,67
3.	Kakanj	Bosnia&Hercegovina	90,2	Lignite	450	1,98	45,56
4.	Ugljevik	Bosnia&Hercegovina	83,3	Lignite	300	1,59	52,39
5.	Kostolac	Serbia	80.7	Lignite	1010	6,23	12,95

Emissions of various pollutants are at the level of all European power plants, indicating the most pronounced emissivity of sulfur oxides compared to other pollutants in Serbia. That is a consequence of the lack of desulphurization procedures in the recent past. This was partially changed in the last 2 years when the desulfurization system in TPP Kostolac worked for a certain number of hours. Currently, the only desulphurization plant in Serbia is the Kostolac B thermal power plant (blocks B1 and B2) [10].

Due to the fact that the desulphurization plant at TE Kostolac B started operating during 2020 (trial mode), the exceedance of the maximum values for SO₂ was less [10]. Different emissions of pollutant from coal-fired thermal power plants in Serbia exceed the permitted maximum values defined on the basis of the "Strategic Impact Assessment for the National Emission Reduction Plan (NERP)"¹ [14]. Other thermal power plants in Serbia had a much higher excess of the allowed emission according to NERP, which is 54575 tSO₂. SO₂ emissions during 2021 were at their lowest level since 2010, which is shown in Table 3 [11, 14]. Nevertheless, coal-fired thermal power plants in Serbia still enormously exceed the permitted values, so the lowest emission value from 2021 is five times higher than the permitted value.

Table 3. SO₂ emissions from coal-fired power plants in Serbia [11, 12]

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
SO ₂ (t)	325400	368100	339500	315900	303900	326100	376000	347700	365300	326700	355100	279200
Max. permitted value (t)	54575	54575	54575	54575	54575	54575	54575	54575	54575	54575	54575	54575
Difference (times)	5,96	6,74	6,22	5,78	5,56	5,97	6,88	6,37	6,34	5,98	6,5	5,11

A decrease in the amount of emitted substances in 2021, especially SO₂, was observed. This was achieved with the active desulphurization system, so the emission decreased by 140% compared to the previous year, by 75900 t SO₂.

Emissions of SO₂ in Germany, Poland and Serbia, as one of the most intensive emitters in Europe are given in table 4.

Table 4. SO₂ emissions from coal-fired power plants in Germany, Poland and Serbia [5, 11]

Emissions	Parameter	Serbia	Poland	Germany
SO ₂	Amount of emission [tons]	279200	98800	102470
	Ratio to the area of the territory [tSO ₂ /km ²]	3,15	0,28	0,33
	Ratio to the number of inhabitants [kgSO ₂ /st]	40,88	2,62	1,23
	Ratio to electricity production [kgSO ₂ /MWh]	11,63	0,76	0,70

3. PROJECTION OF SO₂ EMISSIONS

By studying the data on the amount of sulfur in the coal seam, the expected exploitation of coal in the coming period, as well as the operation of the desulfurization system, a projection of SO₂ emissions in the period up to 2040 was created.

TE Kostolac B is currently the only plant with installed desulfurization systems. The desulphurization system is only in the initial stages of its operation, based on the operating parameters of the system. Until 2021, the Kostolac B thermal power plant was one of the biggest sulfur dioxide polluters in Europe. In 2021, the Kostolac B thermal power plant began to reduce sulfur dioxide emissions due to the start of operation of the desulfurization system.

There is a clearly expressed dependence between the amount of sulfur oxide emitted and the calorific value of the coal used. Projection of SO₂ emissions in the Kostolac B thermal power plant is given in Figure 5.

¹ "Strategic Impact Assessment for the National Emission Reduction Plan (NERP)" [14]

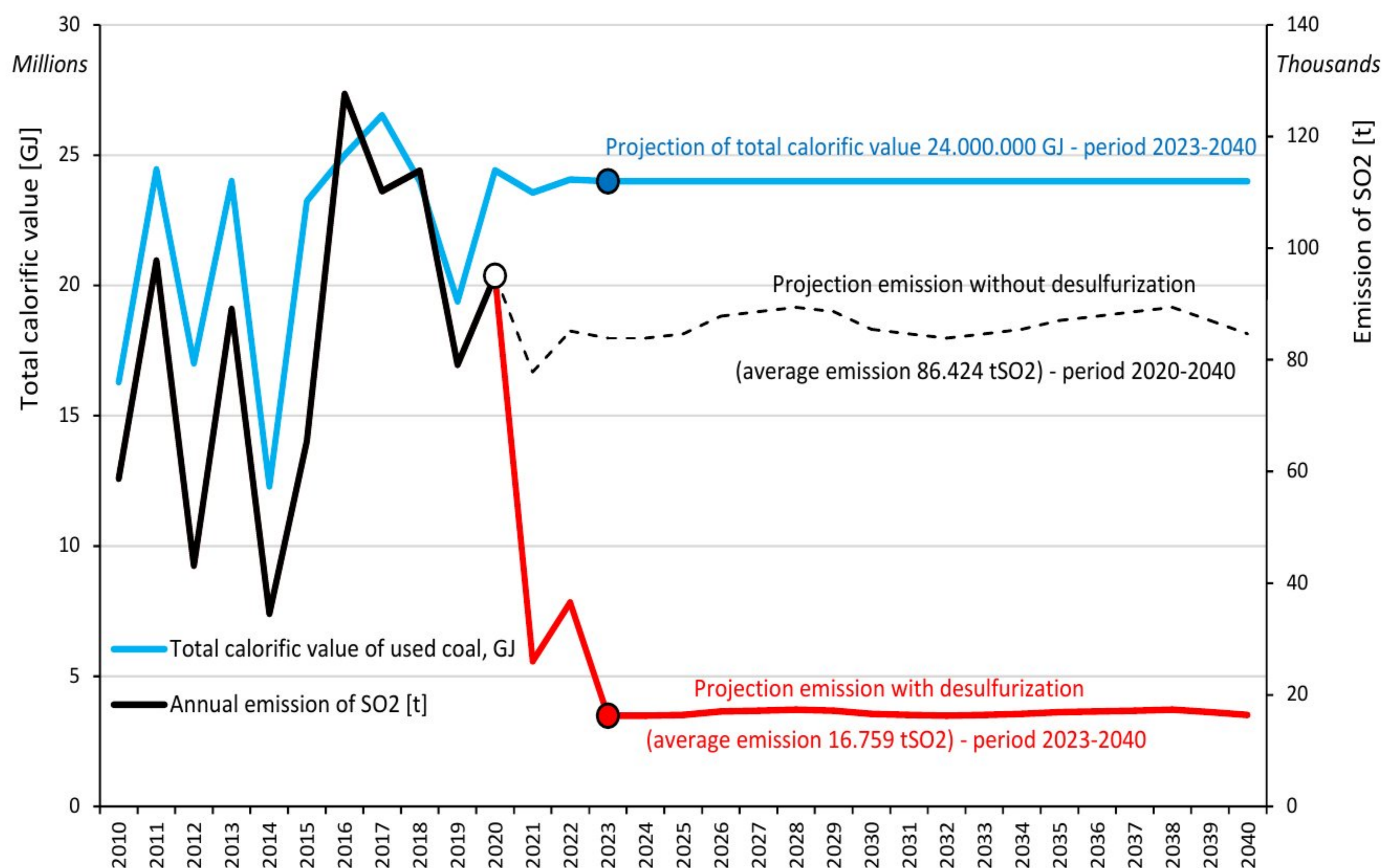


Figure 2. Projection of SO₂ emissions in the Kostolac B thermal power plant

The desulfurization system must remove SO₂ by more than 5 times the total amount of SO₂ input. Out of the total average amount of SO₂ produced in the amount of 86424 t, an average of 16759 t of SO₂ should go into the atmosphere. This value represents the permissible limit.

4. CONCLUSION

Air pollution from coal-fired thermal power plants knows no national borders. Through the paper, it was pointed out that the area of Southeastern Europe represents a region that is among the largest emitters of pollutants from coal burning. Therefore, it is extremely important to use technologies that are available with the aim of constantly improving systems that reduce the emissivity of pollutants in coal-burning plants. It is especially connected with desulphurization system.

This technology of SO₂ reduction can serve as an initial motivation for other thermal capacities in the country and in the surrounding area. The SEE region is treated as the biggest polluter in Europe with SO₂. In addition, the desulphurization system contributes to an additional reduction in the emission of suspended PM10 particles by more than 50%, which is also a benefit.

Also, the data show that in 2022, TPP Kostolac B spent 79741 MWh on the desulphurization process, that is, about 16 MW of the installed capacity was engaged during the operation of this system. Considering the importance of environmental protection, this way of energy consumption represents profit.

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