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USING INDICATORS TO ASSESS THE CONSEQUENCES OF SERBIAN ENERGY SECTOR FUNCTIONING DURING COVID-19 STATE OF EMERGENCY

Abstract: *The emergency situation of global proportions caused by the COVID-19 virus has had an overall impact on the energy sector. The global economy is not at its full capacity, so there has been a decline in electricity consumption in all countries where population, to a greater or lesser extent, has been exposed to viral infection. Energy sectors record a 20% decline in electricity consumption, depending on the number of infected people and the level of economic activity. The implementation of indicators plays an important role in assessing the spread of infection, which occurs as a consequence of work activities related to electricity production. This paper emphasizes the significance of implementing indicators to determine the manner and the cause of virus transmission, with the aim to plan protection measures in the event of a new outbreak.*

Key words: COVID-19, energy sector, indicators, emergency situation

INTRODUCTION

The Electric Power Industry of Serbia recorded a decrease in consumption during the highest coronavirus activity, compared to the same period in previous years. The state of emergency [1,2], as a cause of disruption in industrial and energy systems, has had an impact on business and human health. For this reason, it is necessary to analyze possible consequences in a timely manner [3]. During the state of emergency, the industry operated at slightly reduced capacity; however, the reduction in energy consumption in Serbia turned out to be lower than in other European countries. It is considered that electro power systems in the Balkans [4] have performed well and have maintained significant stability in operation during COVID-19 age. At the period of the most severe pandemic in Italy, there was a decline in electricity consumption by 20% (according to the Anadolu Agency), while in France there was a drop of about 16% and in Spain about 8% [5, 6]. Northern Macedonia recorded a larger decline in energy production, compared to neighboring countries. The global oil industry is also experiencing changes [6]. Storage capacities have been almost full, which means that reduced traffic influenced the significant reduction in oil consumption and even a drop in prices globally. Temporarily closed oil fields stabilized the oil price; however, the costs have incurred due to the resumption of oil exploration activities. Interestingly, the drop in oil prices on the world market did not trigger the drop in fuel prices at gas stations. The cause of such disbalance is justified by the fact that fuel stocks were procured before the pandemic, at the time when the prices were higher. During this state of emergency, fuel consumption was low, so there was no

possibility of buying oil at a lower price since storage spaces are full.

The need for coal has also been reduced, as a result of reduced electricity consumption. However, thermal power plants in Serbia [7] operated with the same capacity, which means that the planned exploitation remained at the same level. The impact of the state of emergency and lockdown on the decrease in energy consumption is not significant [8]. On the contrary, reduced traffic significantly contributed to reduced air pollutant emissions. In addition, the lockdown caused by the biological agent brought about more favorable conditions for the entire living world. Reduced fossil fuel consumption saved the environment from degradation.

THE NUMBER OF COVID-19 INFECTIONS IN SERBIA AS AN INDICATOR USED TO CONTROL STATE OF EMERGENCY

The number of people infected with the virus has varied significantly in different countries, so it means that without indicators we cannot make a real assessment of the situation. With the analysis of the number of people infected per population or the size of the state, i.e. with the use of indicators [9], we can obtain a clear insight into the problems that have arisen. An indicator, such as the number of deaths per total population of the country or per million inhabitants [9], is an item that can be comparatively analyzed. In that case, an indicator is a ratio between the number of deaths and the number of inhabitants [9]. For this purpose, we compared the situation in European countries, with special emphasis on the situation in Serbia.



Figure 1. Total confirmed COVID-19 deaths per million people in Europe [9]

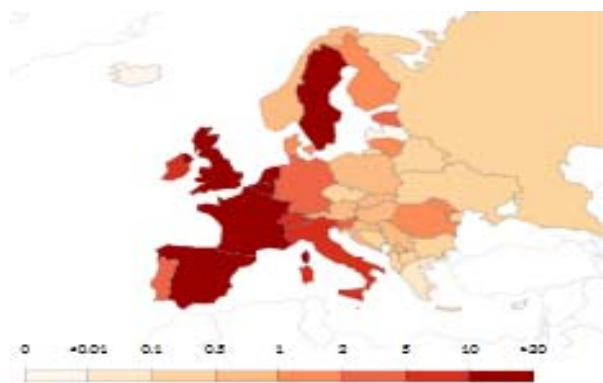


Figure 2. Daily confirmed COVID-19 deaths per million people [9]



Figure 3. Total confirmed COVID-19 cases per million people [9]

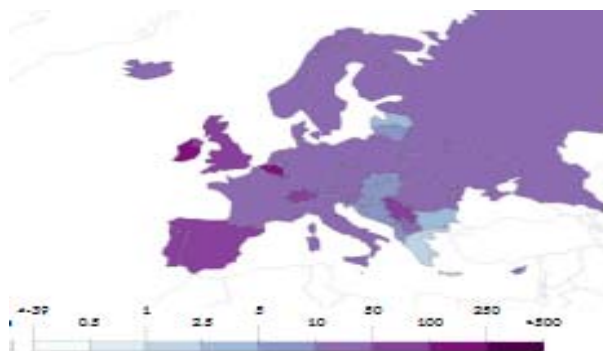


Figure 4. Daily confirmed COVID-19 cases per million people [9]

The analysis of the estimated number of deaths was done on April 16, 2020, when it was determined that the miners could influence the spread of the epidemics in Eastern Serbia. The number of COVID cases per million people, presented on the Our World in Data platform, [9] was obtained by dividing the population number (provided by the United Nations World Population Prospects) by the number of deaths published by the European Center for Disease Prevention and Control (ECDC) [9].

For Serbia, the value of the indicator was 14.55. Based on Figure 1, it can be concluded that the situation was similar in most countries in the region. The situation turned out to be more favorable in Croatia, Montenegro, Bulgaria and Greece. The daily number of deaths per million inhabitants is the ratio of deaths to the number of inhabitants, multiplied by one million [9]. The value of the indicator for Serbia was 0.73, which is significantly lower than in Romania, but higher than the indicator for Bosnia and Herzegovina, Montenegro, Bulgaria and Greece (Figure 2).

The indicator related to the number of confirmed COVID-19 cases in terms of the population size is presented in Figure 3. The value of the indicator for Serbia is 716.13, which is significantly higher than in the surrounding countries. Daily confirmed COVID-19 cases per million people are an indicator presented in Figure 4. The value of the indicator for the territory of Serbia is 59.96, which is significantly higher than in the surrounding countries. It should be borne in mind that the data used in the analysis are not fully comparable, because the diagnostic tests are not the same in terms of their characteristics and accuracy. However, those are the official data across the countries at the global level, and therefore, this is the only way to perform a comparative analysis.

SERBIAN ENERGY SECTOR FUNCTIONING DURING COVID-19 STATE OF EMERGENCY

The outbreak of the epidemic caused by the COVID-19 virus in Serbia was declared on March 19, 2020, when the significant level of risk for infection was confirmed on the territory of the state. Although a state of emergency slowed down the country's economy, the regular supply of electricity continued, and employees in this sector followed the prescribed measures. Serbia Electric Power Industry (srb. Elektroprivreda Srbije - EPS) continued transformation of the primary energy source of coal and hydro potential into electricity during these circumstances. The generation of electric power in thermal and hydropower plants was not interrupted, and coal exploitation continued despite the reserves available in coal warehouses. The distribution system also functioned as in the period before the state of emergency was declared. The installers performed their everyday activities smoothly, and therefore, a regular supply of consumers was ensured.

Social distancing measures and a slower rate of reduced electricity consumption. Serbia Electric Power Industry, as well as the energy sector of the surrounding countries, have provided an orderly supply of electricity. The employees in administration worked remotely from their homes. It is interesting to note that the energy sector in Slovenia organized fourteen-day shifts in the control center, in order to avoid problems with regular supplies.

The measures at the Krško Nuclear Power Plant in Slovenia involved taking employees' body temperature at the entrance. The employees in the energy production sector in Greece had restrictions on movement by which they were allowed to go only from home to work. They were not allowed to use public transport nor to have contact with their colleagues working in the second shift. It is interesting to note that there have been many requests by citizens to connect to the network of solar panel plants in Greece. On the contrary, China reduced the delivery of solar technology to other countries.

THE NUMBER OF MINERS INFECTED - AN INDICATOR OF THE ENERGY SECTOR IMPACT ON VIRUS SPREAD

Serbian energy sector operated at full capacity during the state of emergency [4], following the preventive protective measures. Surface exploitation of coal in the Mining Basins "Kolubara" and "Drmno" (near Kostolac) was carried out following hygiene procedures. Special attention was paid to the jobs in the excavators to avoid interruptions in coal excavation. However, in the Kolubara Mining Basin [4], coronavirus infection was confirmed in five workers, while one employee passed away due to coronavirus infection. Within the mining complex "Resavica", there are 9 mines with underground exploitation. In the "Rembas" mine in Resavica, one miner was positive [4], while the family members of two miners were infected. There are no reports of infected miners in the Vrška Čuka mine.

In the "Lubnica" mine, one miner was infected with the virus [4], and tests showed that they were positive for COVID-19. All of them, 309 miners were sent for testing. In the mine "Bogovina", two miners were infected with the virus, out of a total of 210 workers, or 122 workers [4] employed in pit exploitation. The first infected person was discovered on 15.04.2020 and immediately sent to isolation. They were given protective equipment, face masks and disinfectants [4] on 25.03.2020.

There were COVID 19 infected miners at the Soko and Lubnica mines which operated at reduced capacity. It is considered that the transmission of the infection occurred due to social distance issues, especially during the shift change (several times a day). On those occasions, more than a hundred miners pass by each other. The places associated with virus transmission are

the bus for worker transportation and shared small premises. The cramped space of the locker rooms and bathrooms which are used after leaving the pit at the end of working hours are the places where infection can spread very easily.

In the brown coal mine "Soko", between Knjaževac and Sokobanja, only one in 300 miners was tested positive for COVID-19. The infection was discovered on 09.04. 2020. [4] in the period when the scope of work was reduced. The first measure was to send the workers from the municipality of Knjaževac, who worked in the same shift with the infected miner, on vacation. The bus was assumed to be the place of the virus spread. However, the virus continued to spread among the miners from Sokobanja and Aleksinac.

The mine was operating at the same capacity when infection was detected in 14 miners from Aleksinac, Knjaževac and Sokobanja. It was concluded that the infected miners had mild symptoms, and luckily, there were no deaths. Some were in home isolation, while others were hospitalized. The production in the mine stopped, except for the maintenance of the pit facilities. Figures 5, 6 and 7 show the number of infected citizens in Knjaževac, Sokobanja and Aleksinac, to present the overall impact of the COVID-19 virus spread in the "Soko" mine.

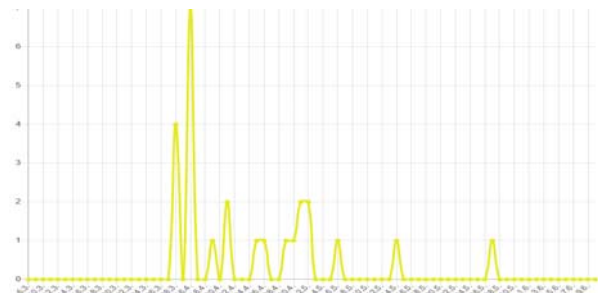


Figure 5. The number of infected inhabitants of Knjaževac [10]



Figure 6. The number of infected inhabitants of Sokobanja [10]

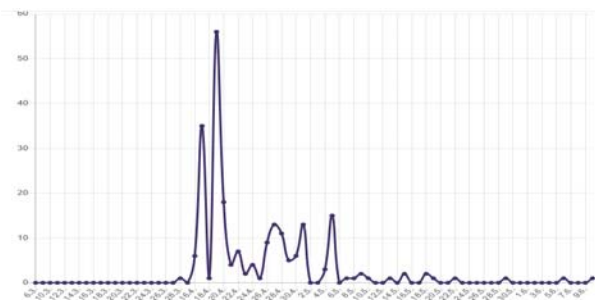


Figure 7. The number of infected inhabitants of Aleksinac [10]

Based on the graphs, it is clear that the spread of the virus among the miners in the "Soko" mine has had an impact on the number of infected citizens in the surrounding areas. In the period when the miners gradually became infected, the infection was transmitted to other inhabitants, more exactly to the people they had been in contact with. However, it can also be noticed that before the first infected miner in the "Soko" mine, an infection with the COVID-19 virus appeared in Knjaževac, on 28.03.2020. This indicates that the infected miner from Knjaževac was in contact with his colleagues and that there is a possibility that the infection was transmitted before the symptoms appeared; therefore, on 16.4.2020 the number of infected in Knjaževac (seven) increased, and the first cases in Sokobanja (twelve) appeared. Only a day later, on 17.04.2020, the symptoms began to manifest in Aleksinac, and the management of the "Soko" mine hired workers only for maintenance work. The workers were sent for examinations, and 25 miners were found positive for COVID-19 [4], mostly with mild or no symptoms.

THE PERCENT OF MINERS INFECTED - AN INDICATOR OF THE SITUATION IN THE MINES

The percentage of infected miners (I_m) as an indicator of the situation compared to the total number of miners as an indicator of the impact of the state of emergency in the mines, points to the problems with the prescribed preventive measures.

The percentage of infected miners is calculated based on the following formula:

$$I_m [\%] = \frac{I_m}{T_m} \cdot 100 \quad (1)$$

where:

I_m –the number of infected miners

T_m –total number of miners in the mine.

Table 1 presents a comparative analysis of the percentage of infected miners [4] in underground mines.

Table 1. The percent of infected miners

Mine	I_m	T_m	$I_m [\%]$
Bogovina	2	210	0,95
Bogovina*	2	122	1,64
Lubnica	1	309	0,32
Soko	14	300	4,65

It can be seen that the highest percentage of infected was in the underground mine "Soko", which indicates the need for more rigorous preventive measures, and controls while wearing prescribed protective equipment. The number of confirmed COVID-19 cases in Serbia by date has been given based on the official database of Serbia. The graph below shows that the viral infection appeared in the "Soko" mine in the days with the highest number of positive COVID-19 cases.

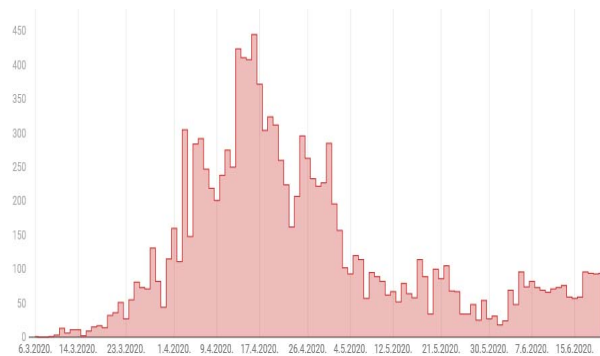


Figure 8. The number of COVID-19 confirmed cases in Serbia [10]

Figures 5 and 6 and 7 show that before the spread of the virus in the mine, there had been no registered cases in any of these three cities, although in Figure 8 we can see that the COVID-19 had been active in Serbia for more than a month. Nevertheless, the ratio of the infected miners and the infected citizens points to the great influence of direct indoor contacts between miners.

It should be borne in mind that workers from surrounding towns and areas are employed in this mining complex. This fact makes it a suitable location for infection spread since it is almost impossible to avoid direct contacts. With an insight into the real situation in the "Soko" mine and the surrounding towns, near Zajecar, and based on the indicators of the virus spread in the energy sector, we have got the impression that there is a need for more rigorous control of protective measures.

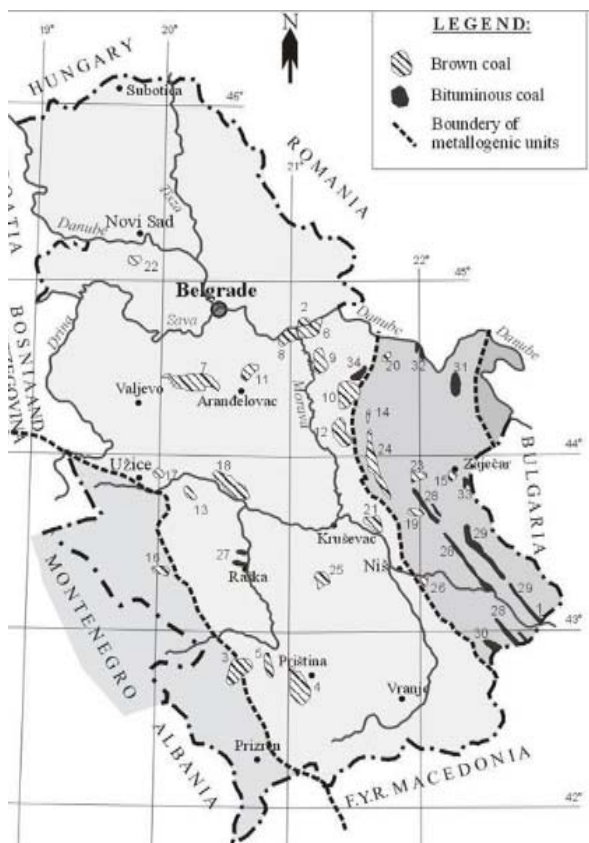


Figure 8. Locations of mines in Serbia [11]

ENERGY SECTOR FUNCTIONING AND THE DECREE ON THE ORGANIZATION OF WORK ACTIVITIES DURING THE EMERGENCY

Pursuant to Article 200, paragraph 6 of the Constitution of the Republic of Serbia, the Government of Serbia passed the Decree on the organization of work activities during the state of emergency, 05 number 110-2517/2020 in Belgrade, on 16.03.2020[12]. The Decree regulates the special manner and organization of work by employers on the territory of the Republic of Serbia during the state of emergency. Article 4 of the aforesaid regulation has been applied, having in mind the production in the mines, the technology of underground coal exploitation and the activities of ore extraction. It is prescribed that the employer, in case where it is not possible to organize remote work or work outside the premises, is obliged to provide all general, special hygiene measures to ensure safety and health of employees and other persons under the Law on the protection of population from infectious diseases. The employer is also obliged to provide sufficient protective equipment following special regulations for employees who are in direct contact or share the workspace with other persons.

The Decree expired on 06.05.2020, according to Article 2 of the Law on regulations validity issued by the

Government and signed by the President, and finally confirmed by the National Assembly. The law was published in the "Official Gazette of RS", no. 65/2020 of 6.5.2020. In accordance with the prescribed recommendations, it is necessary to organize the energy sector, with special attention to protective measures in underground coal mining, where due to specific work conditions, it is not feasible to keep a 2-meter distance.

CONCLUSION

The analysis of the impact of the COVID-19 virus spread on the territory of Eastern Serbia, which occurred as a consequence of infection detected among miners from Knjaževac, showed that the mines with underground exploitation may influence the duration of the state of emergency.

By using the indicators to analyze the consequences of the COVID-19 virus in the energy sector, it was determined that the measures from Article 4 of the Decree on the organization of work activities during the state of emergency should be strictly followed in order to avoid the situation which happened in April 2020. It is necessary to control the implementation of preventive measures, but also to take into account the timely implementation of corrective measures. The decision to send the miners off the work to their home towns around the mine yielded the desired outcome because they spread the virus to their colleagues from other two towns during the incubation period. Also, one of the preventive measures was to order the whole shift of miners who worked with the infected miner to stay at home, but even this did not prevent the spread of the infection. It was concluded that in case of failure of preventive measures, the coal exploitation should stop immediately and all workers should be tested. This idea aimed to avoid consequences to the miners and their colleagues and inhabitants in the surrounding settlements, with the aim to maintain the stability of the energy sector and minimize the transmission of the virus.

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BIOGRAPHY of the first author

Jelena Malenović-Nikolić was born in Knjaževac, Serbia, in 1974. She received a diploma in environmental protection engineering and the Magister of technical sciences degree from the University of Nis, Faculty of Occupational Safety.



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PRIMENA INDIKATORA U PROCENI UTICAJA VANREDNE SITUACIJE IZAZVANE VIRUSOM COVID-19 NA FUNKCIONISANJE ENERGETSKOG SEKTORA SRBIJE

Jelena Malenović-Nikolić, Dejan Krstić, Darko Zigar

Rezime: Vanredna situacija izazvana virusom COVID-19, svetskih razmeta, ima uticaj i na energetski sektor. Privreda na globalnom nivou ne funkcioniše punim kapacitetom tako da se beleži pad potrošnje električne energije u svim zemljama čiji su stanovnici, u manjem ili većem broju, izloženi virusnoj infekciji. Energetski sektori beleže pad potrošnje električne energije i do 20%, zavisno od broja inficiranih i nivoa privredne aktivnosti. Primena indikatora ima važnu ulogu u proceni širenja infekcije, koje nastaje i kao posledica radnih aktivnosti na obezbeđivanju potreba za električnom energijom. U radu se ističe značaj primene indikatora zbog lakšeg definisanja načina i uzroka prenošenja virusa, kako bi se planirale mere zaštite u slučaju da se ponovi prisustvo virusa.

Ključne reči: COVID-19, energetski sektor, indikatori, vanredna situacija.