Sustainable development and coal consumption in Slovakia

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Abstract. The problem of the humanity of the present time is to ensure the energy needs, because the energy need is constantly increasing. It is determined by factors, e. g. the increasing number of inhabitants on Earth, the growing demands of people, etc. However, the limitation of fuel resources is a threat that humanity faces, and at the same time, the burning of fossil fuels also leads to serious damage to the environment. Currently, fossil fuels are mainly used for the heat production, electricity and for driving motor vehicles. The consumption of coal in Slovakia is also decreasing and today it is at the level of 5%, which is a decrease of more than 40% since 1980. Coal is mined in only one place in Slovakia and given the limited coal reserves we must import coal from abroad. In the Slovak thermal power plant Vojany occurs by coal combustion as an undesirable slag ash mixture deposited on the tailing pond. The new environmental solution uses waste at the tailings pond as a source of energy, the volume of coal mining will be reduced and at the same time the requirements of the 2030 Agenda for Sustainable Development will be fulfilled.

1 Introduction

Coal is a fossil fuel that has been used as an energy source for almost 2,000 years. In Europe at the beginning of the 17th century, it was widely used for heating houses. However, the true importance of coal to civilization did not become apparent until the second half of the 18th century, after the invention of the steam engine, when it quickly became the primary source of energy during the Industrial Revolution. During electrification, its importance increased significantly.

Energy is the basis of all processes that take place in our surroundings. It is one of the most important factors affecting the development of society. Humanity needs energy and heat to meet its needs. With the development of civilization, the demands for their need are constantly increasing.

Industry needs energy for its operation, but also people for their existence. The problem of humanity today is ensuring energy needs. Energy demand is constantly increasing. It is determined by factors, e.g., the increasing number of inhabitants on Earth, the growing demands of people, etc. [1]

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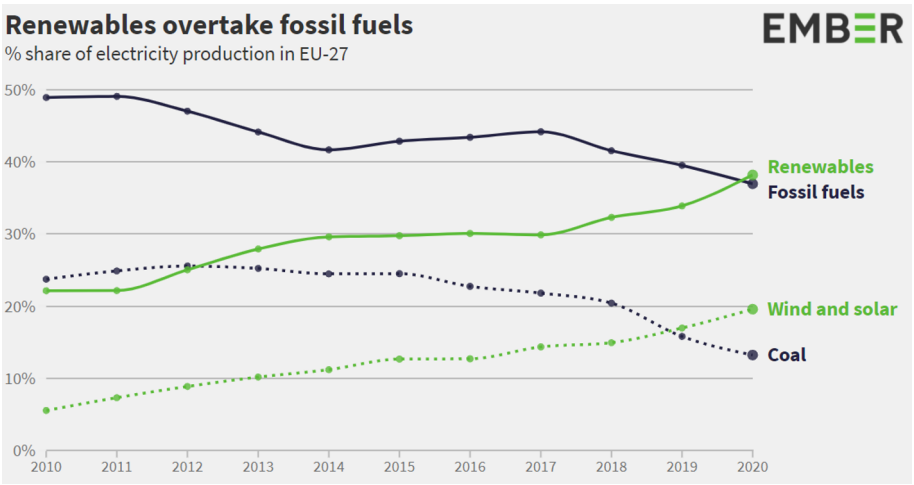

Fig. 1. Electricity production in the EU-27 [2]

The EU-27 has made considerable progress and produced more electricity from renewable sources than from fossil fuels in 2020 for the first time. Renewable energy sources increased to 38 % of electricity production in Europe in 2020 (compared to 34.6 % in 2019), what is the first time it has overtaken fossil fuel-burning production, which fell to 37 %. However, the transition from coal is still too slow to achieve a 55 % reduction in greenhouse gases by 2030 and climate neutrality by 2050. [3]

The following figure shows energy consumption in Slovakia. Coal consumption has decreased by more than 40 % since the beginning of the monitored period.

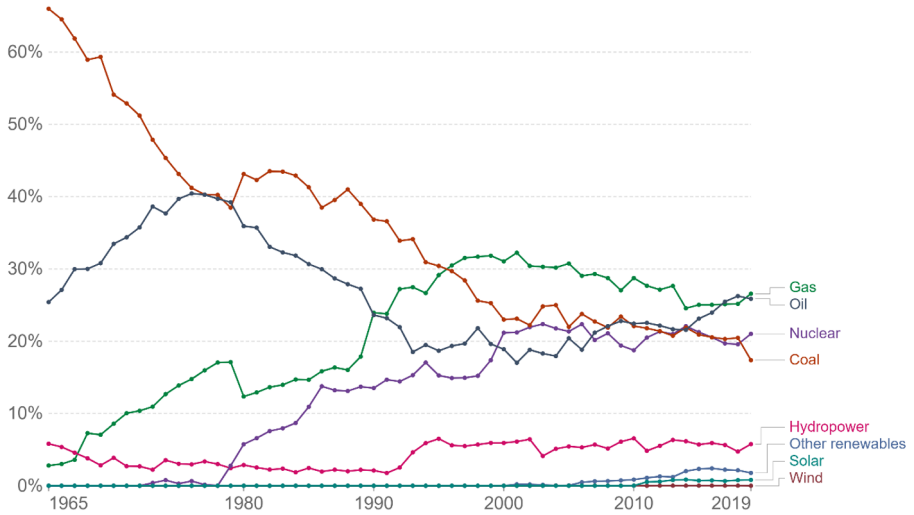

Fig. 2. Energy consumption in Slovakia [4]

Fig. 3. Countries with the largest production of electricity from coal, 2020 (%) [2]

The International Energy Agency (IEA) said in its latest estimate that the total demand for coal in the world increased by six percent in 2021. In addition, the demand for coal could reach a record in 2022. This would mean the exact opposite of the desired development, which is the reduction of greenhouse gas production.

China produces more than half of the global production of electricity from coal, with an increase of nine percent in 2021. The production of electricity from coal in India also increased significantly, by 12 percent. [3]

2 Materials and Methods

2.1 Coal reserves in the world and in Slovakia

Large reserves of coal, whether lignite or anthracite, are located on the territory of Russia. Equally significant reserves are in North America and China. Together, these 3 countries have up to 2/3 of the coal reserves.

In 2018, about 8,013 million tons of coal were mined in the world. Compared to 1990, coal consumption in the world increased by 60 % in 2018. China became the leader in coal production with an indicator of 3,683 million tons. In general, the highest growth rate of coal production is recorded in the countries of the Asia-Pacific region. [5]

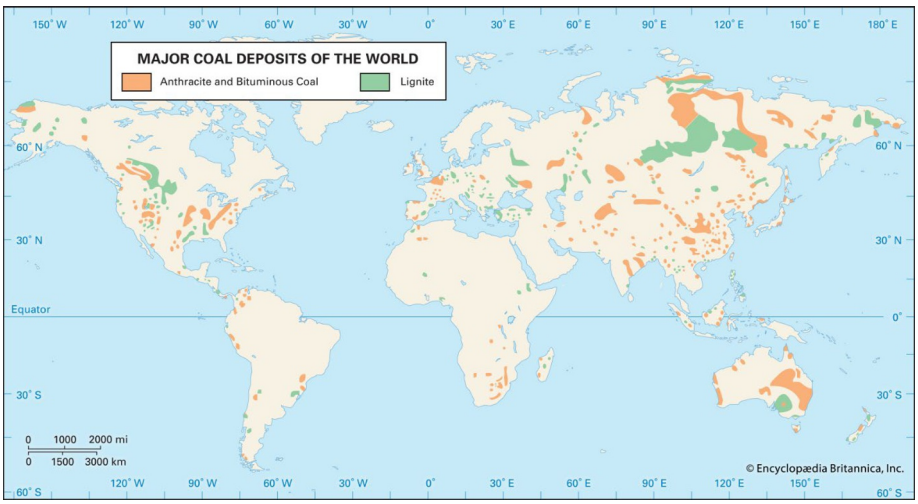

Fig. 4. Anthracite and lignite reserves in the world [6]

Fig. 5. Brown coal and lignite deposits in Slovakia [1]

In Slovakia, coal is mined in only one place – in the mines of Horná Nitra. In 2023, Slovakia will stop supporting lignite mining. However, the mines themselves claim that the end of state support for coal mining does not mean the end of coal mining in Slovakia. Due to the limited coal reserves in Slovakia, we must import coal from abroad, and one of the countries that import coal is Russia.

World coal production has increased several times over the last century and a half. The lifetime of the world's coal reserves is often calculated by dividing the reserves by the annual consumption, which gives about 120 years, some figures say as much as 250 years. However, it was found that this figure appears to be the same from year to year as the balance is created by the discovery of new reserves.

2.2 The tailing pond EVO Vojany

The biggest fossil fuel plant in Slovakia is EVO Vojany, where mainly semi-anthracite coal from Ukraine and Russia is used as fuel. Currently, for disposal of waste products from coal combustion the plant operates the facility the tailing ponds with dross ashes mixture.

Ash mixture is the subject of research studies in many countries of the world, in Asia, China [7, 8] and also in Europe, in Poland [9-11], Italy [12] and in Slovakia [13].

Fig. 6. EVO Vojany – tailing pond.

3 Results

Considering the fact that the tailings pond contains reusable unburnt fuel (Nedopal), experimental samples were taken from the cassette at the tailings pond. Individual samples are characterized by the coordinates of the sampling point (longitude and latitude), which are identified as X and Y coordinates in the following graphs. The depth of the sample taken is characterized by two values. The value V represents the altitude of the sample, the value H represents the depth measured from the surface of the sampling site. Of course, these are mutually dependent values (H and V), but due to the unevenness of the terrain, both views are interesting, i.e. considering the altitude, but also the depth.

Fig. 7 presents the graph Matrix plot (nonlinear regression of the percentage share of unburnt fuel with respect to the mentioned four quantities X, Y, V, H).

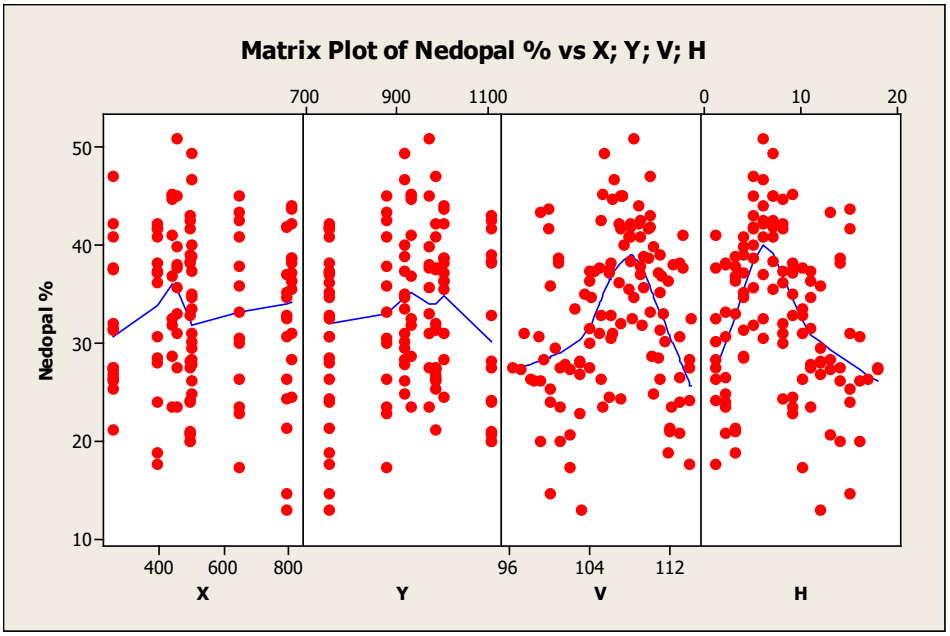

Fig. 7. Percentage unburnt fuel depending on the X, Y, V, H coordinates of the sampling point

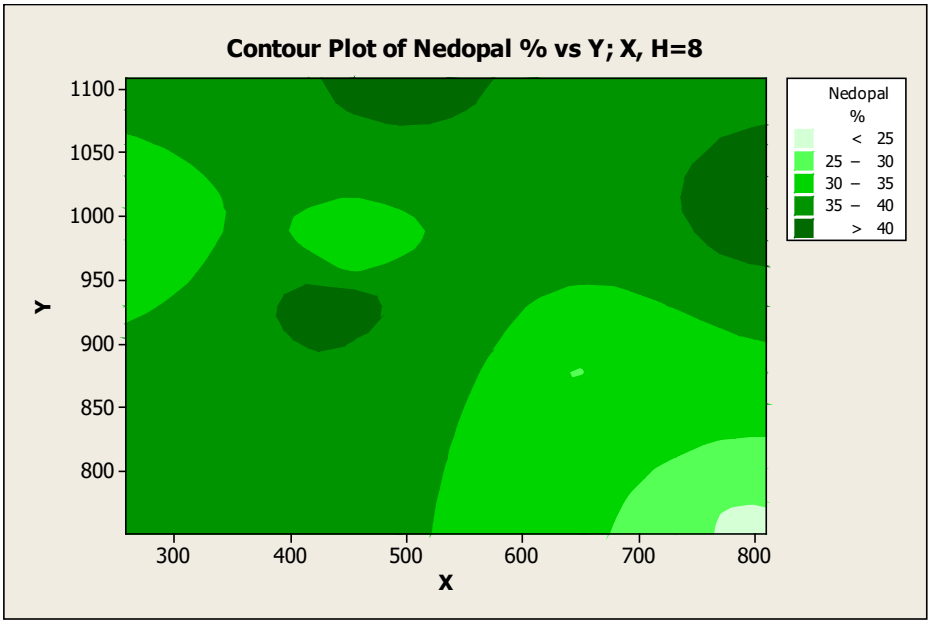

Fig. 8. Percentage amount of unburnt fuel at a depth of 8 m

In Fig. 8 and 9 present stochastic estimates of the share of unburnt fuel in the dry matter of the slag-ash mixture for different coordinates of points X, Y describing individual points of the tailings pond and the constant depth H = 8m, which is indicated in the header of the graph. The occurrence of unburnt fuel is presented in two ways using a graph:

1. Contour plot, where the estimated unburnt fuel values are determined by color (individual graphs represent a section of the sludge at a specific depth H with respect to the share of unburnt fuel,

2. Surface plot, where the estimated value of % unburnt fuel is represented by the Z coordinate of the three-dimensional graph.

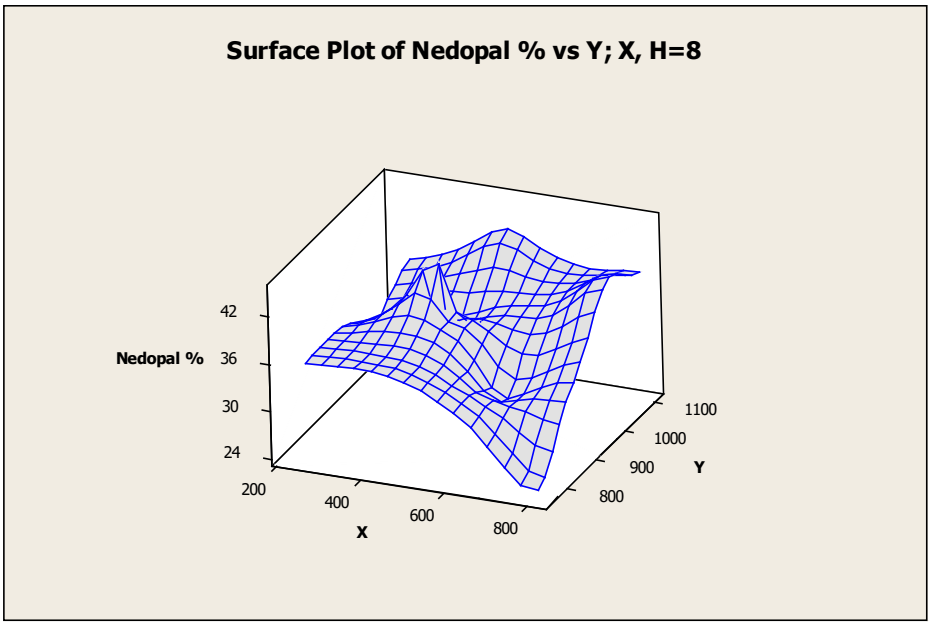

Fig. 9. Displaying the percentage amount of unburnt fuel at a depth of 8 m

The individual sections make it possible to get a basic idea of the heterogeneity of the percentage share of unburnt fuel across the individual deep layers of the tailings pond.

If we consider the geodetic survey of the cassette from 1 m (115 m above sea level) to a depth of 18-20 m from the surface (up to 95 m above sea level), we get a volume of 5,164,800 m3. In this volume there is 1,045,319 m3 of a low ash, which represents 20%.

4 Conclusion

Slovakia is not a country rich in mineral resources and from an environmental point of view, it is forced to use the potential of recycling. The large volume of the tailings tank hides a large amount of unburnt fuel ash, a mixture of slag ash that can be reused in co-firing with black coal. In the near future, new progressive incineration technologies will be able to use the entire volume of the examined sludge for co-incineration, which will improve the ecological value of the sludge tank. The experimental results point to the environmental significance, which, however, will also depend on the economic side of the implementation of the rehabilitation of the tailings pond.

Acknowledgments

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