Sustainable Development and Coal Consumption in Slovakia

Energy is the basis of all processes that take place in our surroundings. Industry needs energy for its operation, but also people for their existence. 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 EU-27 has made considerable progress, producing more electricity from renewable sources than from fossil fuels in 2020 for the first time. Renewables increased to 38% of electricity generation in Europe in 2020 (compared to 34.6% in 2019), the first time it has overtaken fossil fuel-burning generation, which fell to 37%. 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. By using environmentally sound technologies it is necessary to ensure adequate management of this waste, security and long-term stability of tailing pond. By using the Design of Experiments was found that volume of tailing pond is approximately 20% a low ash, which can be repeatedly reused in co-incineration with black coal. The development of combustion technology suggests that it will be possible to use the whole volume of the examined tailing pond for co-incineration, thus reclaiming of the tailing pond basin in an environmental manner. 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.

Keywords: *Sustainable development, coal, tailings pond, environment, Slovakia*

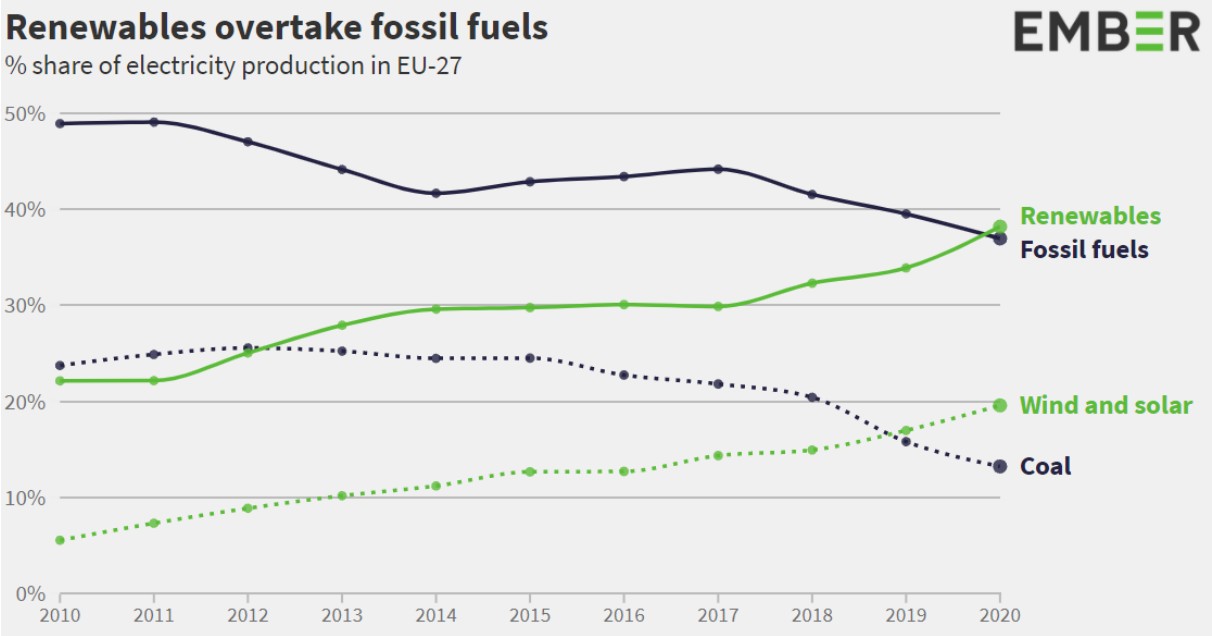
Energy from Coal

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. [9]

Figure 1. *Electricity production in the EU-27*

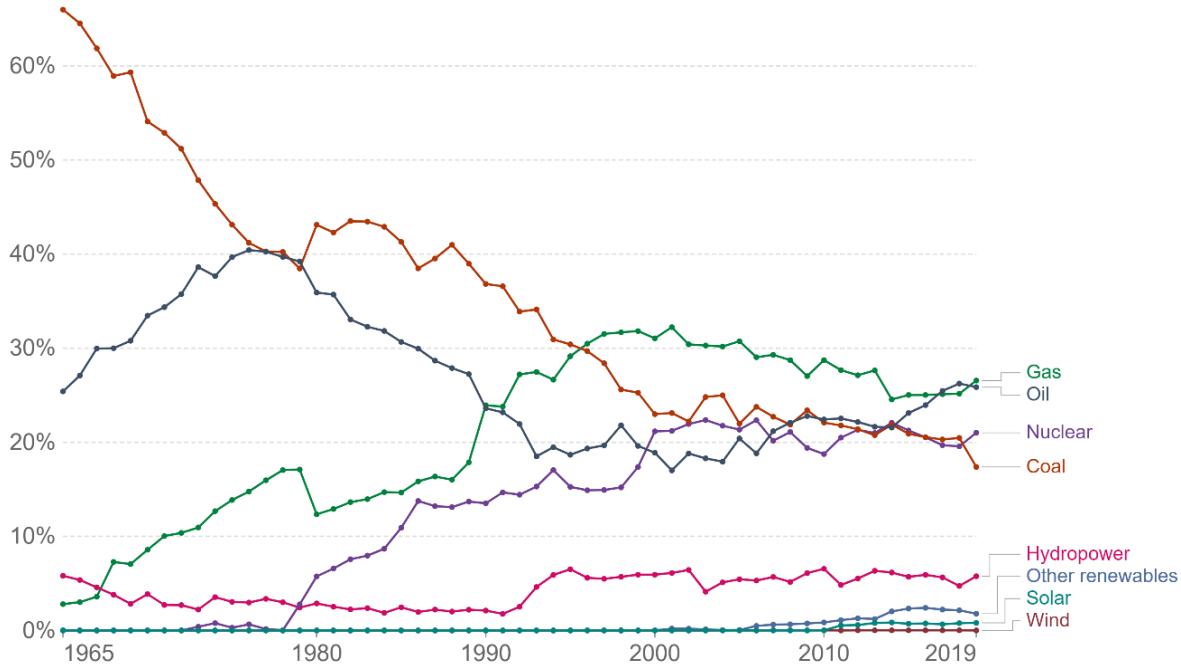


Source: www.ember-climate.org

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. [5]

The following figure shows energy consumption in Slovakia. Coal consumption has decreased by more than 40 % since the beginning of the monitored period. [8]

Figure 2. *Energy Consumption in Slovakia*



Source: www.ourworldindata.org

Figure 3. *Countries with the largest production of electricity from coal, 2020 (%)*

Source: www.ember-climate.org

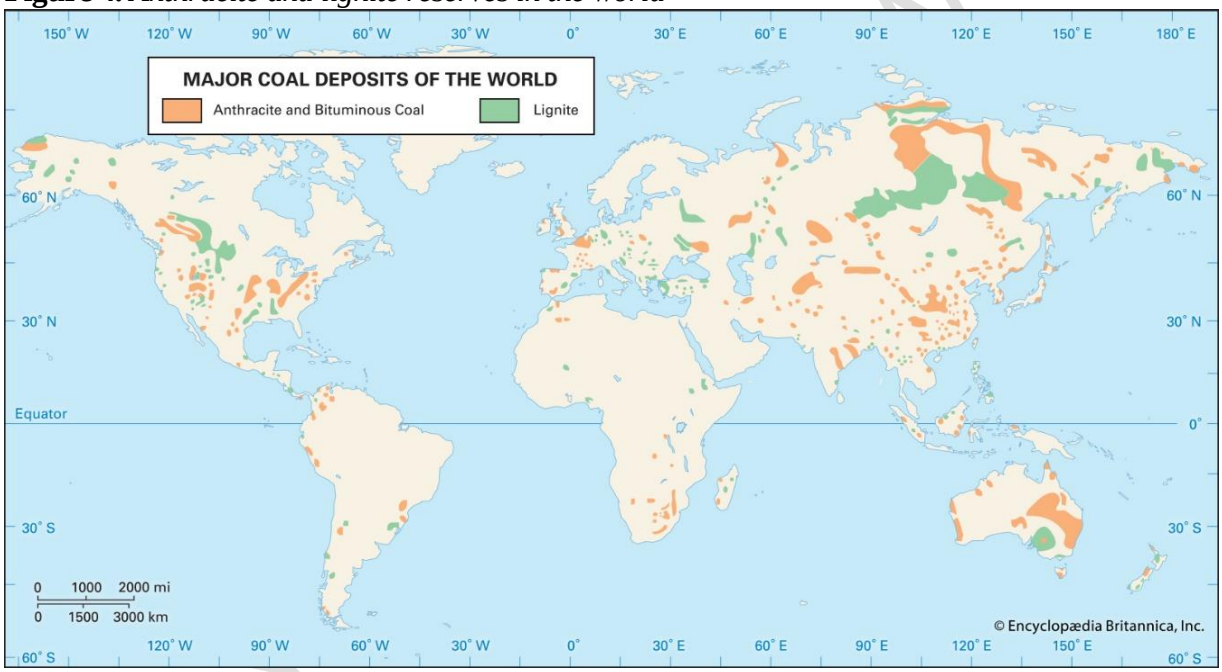
The International Energy Agency (IEA) said in its latest estimate that the total demand for coal in the world increased by six percent in 2021. In addition, the demand for coal could reach a record in 2022. This would mean the exact opposite of the desired development, which is the reduction of greenhouse 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. [6]

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.

Figure 4. *Anthracite and lignite reserves in the world*



Source: www.britanica.com

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. [2]

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.

Figure 5. *Brown coal and lignite deposits in Slovakia*

Source: www.mhsr.sk

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 two facilities:

1. Tailing ponds with dross ashes mixture,
2. Dump with stabilization material tailing.

Safety and operation oversight within the relevant legislation of tailing pond of EVO plant Vojany is needed because it is water work. On the verge of PLA Latorica, on the left bank of the river Laborec it was built in 1965 to store dross ash mixture and located in the administrative area of village Drahňov and Vojany. It is bounded on all sides by raising grass covered embankments. Two separate approximately the same cassettes create the tailing pond:

1. Cassette No. 1 – 29 ha (with dam 47.2 ha),
2. Cassette No. 2 – 27 ha. (with dam 48.12 ha). [1]

Results

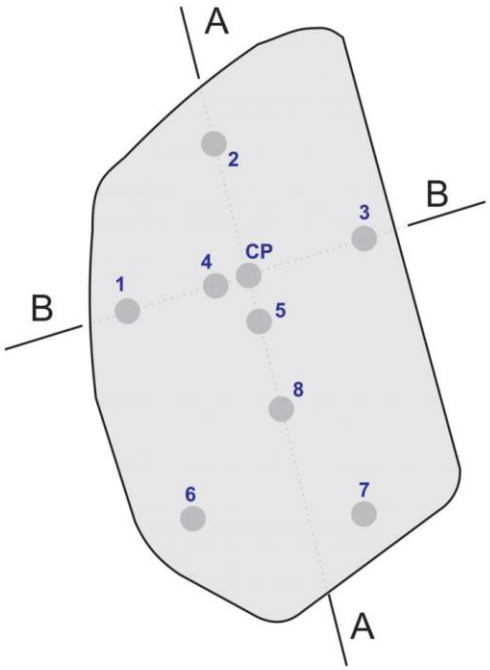
The position of the individual wells on the tailing pond was marked by the method of planned experiments DOE. The boreholes themselves were deployed on a two-dimensional surface, the third dimension, i.e. the depth was done for all

available drilling values up to the cassette subsoil (16m). Samples were taken from each meter of the well. Since the CP can be understood as the arithmetic mean of the distance of the two opposing vertices of the quadrilateral (points 1, 2, 3, 8), the next measurement was made at the point corresponding to the "golden section", at both diagonals of the basic quadrilateral (CP 4 and 5).

The last two boreholes (CP 6 and 7) were placed in such a way that with the three outer points of the said quadrilateral they form a boundary pentagon whose peaks lie at the boundary of possible drilling, i.e. the distance from the individual dykes was determined in such a way that to avoid damaging the dam in the case of a technically constructed borehole.

Fig. 6 shows 9 points of sampling points on the tailing pond – Cassette No. 1.

Figure 6. *Points of the depth boreholes at the bottom of the tailing pond*



The measured experimental results were recorded and the mean values along with minimum and maximum of data for individual meter layers of the longitudinal section of the tailing pond A-A and its cross section B-B.

Both of the sections A-A and B-B go through the central point and give a visual impression of the percentage of undershot of the slug ash mixture on the EVO Cassette No. 1.

Table 1. *Base parameters of tailing pond*

	Longitudinal section A-A			Cross section B-B		
Depth	**Average**	**Min.**	**Max.**	**Average**	**Min.**	**Max.**
1. m	29.99	27.45	32.54	20.91	17.62	24.20
2. m	32.71	26.47	41.03	28.08	20.78	39.41
3. m	24.07	21.14	30.27	23.53	18.86	30.80
4. m	30.95	24.87	35.20	34.17	28.58	39.05
5. m	**40.35**	33.18	47.17	**41.63**	39.90	43.16
6. m	**37.30**	34.78	40.89	**40.19**	35.73	42.58
7. m	**43.27**	40.10	51.06	**43.45**	38.38	51.06
8. m	**38.71**	24.37	46.87	**41.06**	36.25	45.13
9. m	**39.05**	30.60	49.54	**40.13**	37.32	44.78
10. m	37.87	26.35	45.26	33.65	23.53	45.26
11. m	32.80	29.96	34.67	32.45	27.53	37.36
12. m	24.06	13.00	33.55	28.12	27.98	28.23
13. m	24.21	17.34	27.93	20.65	20.65	20.65
14. m	26.83	23.51	29.48	29.17	20.02	38.32
15. m	26.06	14.66	35.85	32.92	24.01	41.83
16. m	31.92	26.10	43.48	25.31	19.90	30.72

The measured and calculated results divide the depth of the tailing pond basin into 3 layers, while in the middle layer is located slug ash mixture with a low ash of over 50 %.

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%.

Conclusion

The results show that the among of slug ash content in the tailing pond mixture with a under-firing in the range of 15-50 %, with a mean depth of 20-35 % at a depth of 1-5 meters, a depth of 5-9 meters in the range of 39-44 % and at a depth of 9-16 meters in the range of 25-38 %.

Due to the total area of the tailing pond, there is a large amount of slag ash mixture, which can be repeatedly reused in coincineration with black coal. The development of combustion technology suggests that in the near future it will be possible to use the whole volume of the examined tailing pond for co-incineration, thus reclaiming of the tailing pond basin in an environmental manner. In order to clarify the values of the underfiring of the slug ash mixture, it is necessary to continue the experiment and carry out further boreholes in the tailing pond to clarify the results obtained, which will follow in the next stage of the project.

References

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