

# The limitation of the methane (CH<sub>4</sub>) emission in the Upper Silesian Coal Basin as a result of the Polish Mining Group closing program.

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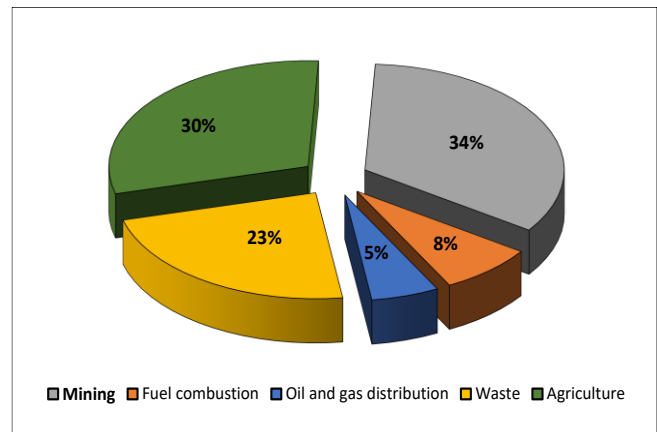
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**Abstract** Hard coal mining is responsible for 9% of the worldwide methane emission to the atmosphere. Methane is the second strongest greenhouse gas after carbon dioxide, but its radiative power is 25-30 times stronger than the radiative power of CO<sub>2</sub>. In the Polish reality, hard coal mining is one of the most important branch of economy due to big amounts of deposited coal in numerous coal seams which is being produced by many coal companies. The biggest active coal basin in the European Union – the Upper Silesia Coal Basin is responsible for 3% in the total greenhouse gases emission and 28% in the total CH<sub>4</sub> emission in Poland. The Polish Mining Group (PMG) – the biggest extraction company in the EU announced that all active coal mines incorporated in the Group will be closed until 2049. Hard coal extraction has been decreasing in Poland since 1997 and the amount of released methane from coal mines direct to the atmosphere exceeded 735 million m<sup>3</sup> in 2015 and remains high till now. The purpose of the study is to predict the results of PMG closing program on methane emission changes in the Upper Silesian Coal Basin until 2049.

**Keywords:** Methane emission, hard coal mining, the Upper Silesian Coal Basin (USCB), the greenhouse effect, air pollution

## 1. Introduction

Methane (CH<sub>4</sub>) is a powerful gas, second only to carbon dioxide (CO<sub>2</sub>) in its overall contribution to climate change and has a significant effect on the climate e.g. contributing to tropospheric ozone formation, causes serious health problems and deaths (West & Fiore, 2005; EU COM 2020(663)final). The European Union's (EU) current policy aims to reduce methane liberation to the atmosphere by 29% by 2030 in comparison to the base year (2005) and achieve complete neutrality by 2050. Poland, as the leading hard coal producer in the EU, emits the biggest volumes of methane coming from underground coal mining. Over 34% of emitted methane in Poland comes from coal mining, 30% from agriculture (livestock breeding) rest from wastes, fuel combustion, oil and gas distribution (Institute of Environmental Protection- National Research Institute, 2020) (Fig.1). The biggest extraction company in the EU – the state-owned Polish Mining Group (PMG) produces hard coal for heat and power production, supplying national and commercial recipients (e.g. Kędzior & Dreger, 2019).



**Figure 1.** The contribution methane emission in Poland.

The changing climate policy, more difficult geology and mining conditions (including natural hazards) and coal deposits depleting, forced the PMG and the Ministry of State Assets to create the fully controlled, mining closing program, which is known as “the Social Contract” signed and agreed by both sides in September 2020 (Ministry of State Assets). The agreement obliges PMG to close all the working mines incorporated in the company till 2049. Fourteen collieries have been active since the beginning of the 2021 but two of those mines are going to be closed in the running year. Scheduled collieries closing will face in coal output reduction but difficult geology conditions are going to result in different methane emission trend in each mine. The list of mine united in the PMG is available on the corporation website (www.pgg.pl).

The geological building of the northern and western areas of the USCB, where PMG mines are located, favors the bigger methane emission during deeper mining works. Methane and other gases are liberated to the coal workings from coal and surrounding rocks (sandstone, mudstones and siltstones) and the concentration of CH<sub>4</sub> in the coal increases as depth increases too. Methane is not only a strong greenhouse gas, but in mining world it is primarily a highly explosive gas. In the adequate concentration (5-15% of CH<sub>4</sub> and >12% of O<sub>2</sub>) single spark can cause an explosion and many lives can be taken (e.g. Karacan et al. 2011). In many ways, CH<sub>4</sub> is first treated as a threat, than as a highly energy source and only later treated as a powerful greenhouse gas which is harmful to our environment (Dreger, 2020).

The purpose of the study is to predict how the methane emission (to the atmosphere) from coal mines is going to change, and how big amounts of this gas will be emitting to the air at the end of “the Social Contract” timeline – which faces with EU expected complete CH<sub>4</sub> neutrality emission in 2050.

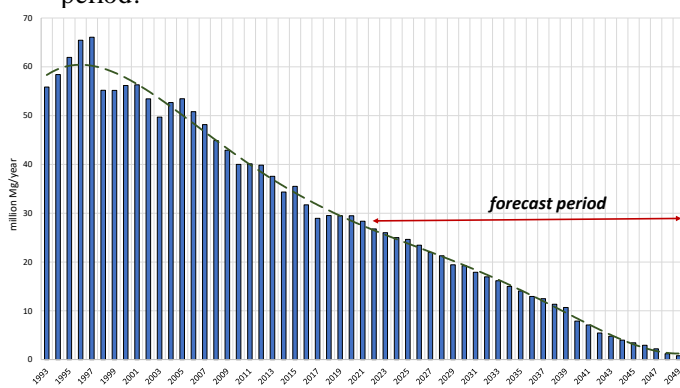
## 2. Method

All the important data (annual hard coal production, total and ventilation methane emissions) were taken from Annual Reports (1993-2020) published annually by Central Mining Institute in Katowice (*Annual Report, 1993-2020*). The forecast of the coal output and methane emissions changes was studied and predicted to every single coal mine united in the PMG. Hard coal production predictions were based on the experience collected from collieries closed before “the Social Contract” assignment. The trend and values of extracted coal in the last years of mining activity were compared with the current and expected market demand on coal. Methane emission is connected strictly with geology and mining conditions, for these reasons, lithology and tectonics of northern, central and western areas of the USCB were carefully analysed. When conclusions had been drawn, simple polynomial equations were fitted to the charts.

## 3. Results

### 3.1 Hard coal production.

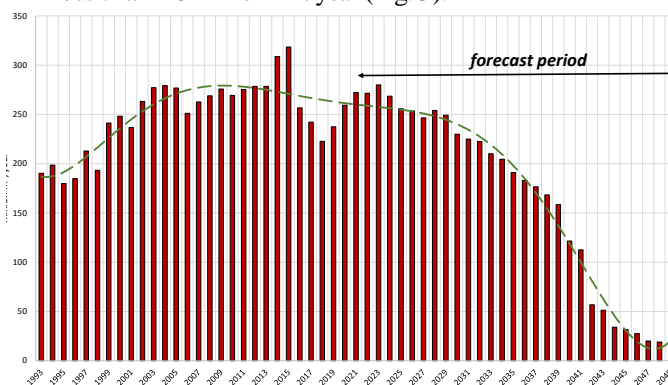
The hard coal output in the Polish Mining Group and in the entire Upper Silesian Coal Basin has been decreasing since late nineties (Fig. 2). The slow down and coal extraction limitation is caused by economic factors (coal seams depleting, low coal prices and higher costs of coal extraction) and mining factors (gaseous hazards, tremor risk, rising temperature etc.). Closing dates assigned in “the Social Contract” will force collieries to limit the production in the last years of its activity. In the other hand, coal mines can be prepared to relocate employees and carry out the controlled shutdown by imposed restrictions. In the forthcoming years, the coal production is going to decrease from 28,5 million Mg in 2020 to less than 20 million Mg from 2039. Systematic closing will result in constant decrease in the volume of extracted coal, therefore “symbolic quantity” (less than 5 ml Mg/year) will be produced in last 7 years of the studied period.



**Figure 2.** Hard coal production in the PMG coal mines in 1993-2049

### 3.2 Methane emission to the atmosphere

The forecasted methane emission is composed of methane vented directly to the air from the ventilation shafts (VAM emission) and unused gas from methane drainage. There are also additional source of CH<sub>4</sub> emission like coal dumps and gas releasing during transport but there weren't taken into consideration. The forecast of greenhouse gases emission is complicated due to rapidly progressing changes and habits in energy, agriculture and waste sector. The detailed studies of historical emission data and methane distribution in deep future-exploited coal deposits made possible to predict amounts of releasing gas in the near and far future. Since 2000, methane emission in PMG collieries has oscillated around 250 million m<sup>3</sup>/year. The author's forecast predicts that gas liberation to the atmosphere is going to decrease in 2029 due to coal production limitation, therefore, six mines will be closed to that period (Fig. 3). The constant decline in CH<sub>4</sub> emission is expected till 2041, when the emission will fall to 112 million m<sup>3</sup>. In 2041-2049 coal will be mined just from 4 collieries, located in the western part of the USCB. The coal production will be limited to the minimum to meet the needs of private and state-owned sector and provide safe and “soft” closing process. Therefore, the methane emission is going to be limited to. Small quantities of extracted coal will result in “symbolic” CH<sub>4</sub> emission – less than 40 million m<sup>3</sup>/year (Fig. 3).



**Figure 3.** Methane emission in the PMG coal mines in 1993-2049

## 4. Conclusions

The hard coal mining is one of the strongest and needed branch of the Polish economy (e.g. Dreger & Kędzior, 2019). In the other hand, the EU restrictions and energetic coal deposits depleting meets with “the Social Contract” signed by the Polish Ministry of States Assets and the biggest extraction company in the EU – the Polish Mining Group. In 2049, the last coal mines united in the PMG will be closed. That agreement will result in methane emission limitation to the atmosphere. From 2041, the emission of methane - a powerful gas, second only to carbon dioxide (CO<sub>2</sub>) in its overall contribution to climate change, will be constant decreasing and in the last 7-8 years the emission is going to be “symbolic”. The results of the Social Contract will fulfill the assumptions of the EU policy, which aims to limit and be methane free till 2050.

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