

The Influence of Methane Emission and Hard Coal Production on Air Quality and Greenhouse Effect in 1994-2017 in the Upper Silesian Coal Basin (Poland)

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Abstract

The Upper Silesian Coal Basin (USCB) is the largest coal basin in Poland and one of the largest in Europe. It is the most industrialized region in Poland. The main natural resource and energy raw material is hard coal which was produced by 65 mines in the early nineties. The USCB geology is very diverse and not homogeneous. Coal deposits situated in the central, southern and western regions are mostly covered by impermeable Miocene deposits which helped methane (CH₄) to accumulate in the past. Methane is one of the most dangerous natural hazard in Polish underground mining because it is explosive gas. CH₄ is also the second strongest greenhouse gas after the carbon dioxide, but its radiative power is 21-25 times stronger than the radiative power of CO₂. Polish coal mines releases 568.9 million m³ (average) of CH₄ yearly and it provides to greenhouse effect increasing. From one year to another, the Upper Silesian coal mines are going to extract hard coal from deeper seams when the methane content is much higher. To keep workers safe, CH₄ need to be captured and released to the open air atmosphere or used to power and heat production.

Keywords: hard coal production, methane emission, greenhouse effect, air pollution

1. Introduction

Air pollution and greenhouse effect increasing is one of the main problem in industrialized regions such as Upper Silesia Coal Basin in southern Poland. During hard coal exploitation, many m³ of CH₄ is releasing to the coal openings enlarging danger and making coal production very difficult at the same time (Kotarba M., Ney R. 1995). Most of coal mine methane (CMM) need to be run to ventilation shafts and release to the atmospheric air – magnifying greenhouse effect. The objective of the paper is to determine greenhouse effect enlargement and air quality at the background of hard coal production processes (mainly methane emissions) in the USCB and entire Poland.

From year to year Polish mines need to produce coal from deeper and deeper seams to maintain profitability and keep

mines working. Reaching deeper coal seams is connected with entering to high methane zone when methane content in one Mg^{daf} of coal is much higher (Kędzior S. 2009). It forces to struggle with CH₄ emission to keep working in mine as safe as possible.

2. Method

To show how methane emissions and coal production in the USCB coal mines affect air quality and greenhouse effect increasing, figures like coal production, emissions of CO, CO₂, CH₄, NO_x, SO_x and dust were taken into account.

All important data were obtained from: *Resources, Use, Pollution and Protection of Waters* (in: Environment, Central Statistical Office, 2005-2018); *A national inventory report 2016 – inventory of greenhouse gases in Poland from 1988 to 2014* (Institute of Environmental Protection- National Research Institute, 2016) and *Annual report about basic, natural and technical threats in hard coal mining* (Krause & Sebastian, 1997-2016, Koptoń, 2017). Based on the analysis of the most important data, figures which show changes and percentage share of responsibility for greenhouse gases emission have been made. The period between 1994 and 2017 overlaps with large decrease in hard coal production, increase in methane emissions and important changes in regulations, heating technologies and types of using coal to heat production. Polish government together with the European Union aims to reduce air pollution and greenhouse effect enlargement.

3. Results

Carbon dioxide (CO₂) is the most common greenhouse gas in the world. Through entire research period (1994-2017) over 300 million Mg of CO₂ (yearly) were emitted to Polish atmosphere (Fig. 1); (Central Statistical Office, 2005-2018 and Institute of Environmental Protection- National Research Institute, 2016). The largest emission took place in period 1994-1997 when 1471,62 million Mg of CO₂ has been emitted (from 362.01 to 377.31 million

Mg yearly). After 1997, decreasing in carbon dioxide emission was noticed with the lowest volumes of CO₂ released to the Polish atmospheric air – 307,54 million Mg in 2002. In next years (2003-2017) emission was slightly increasing and remain on similar level with small oscillations. The second greenhouse gas, taking to the study is methane (CH₄) which is 25 times stronger heat absorbent than carbon dioxide. In Poland, the main CH₄ issuers are agriculture, underground mining, landfills, gas and oil extraction with its distribution (*Institute of Environmental Protection- National Research Institute, 2016*). In Upper Silesia Coal Basin almost all methane emissions come from underground coal mining, specifically from ventilation (VAM emission) and coal dumps. The largest methane emission took place in 2007, when 613.6 million m³ of CH₄ was emitted directly to the atmosphere(Fig.2);(*Krause & Sebastian, 1997-2016, Koptoń, 2017*). Through all studied period VAM emission varies from 528 million m³ (1998,1999) to 613.6 million m³ (2007). From 2007 to 2014 decrease in emission of this greenhouse gas was observed. But in last three years (2015-2017) USCB coal mines released much more methane to the air – more than 590 million m³ yearly.

The Upper Silesia Coal Basin is the most industrialized region in Poland and emission of methane (in USCB) in relation to emission in entire Poland was on high level. But from the beginning of the studies (1994) to 2009 the percentage of USCB methane emission in comparison to whole emission in Poland increased (Fig.3). In 1994 share in CH₄ emission was 16.5 % and had been increasing to 24.76 % in 2009. In next years (2010-2014) percentage of CH₄ emission was on similar level (around 24%) but in last three years (2015-2017) a little drop was observed.

4. Conclusions

The carbon dioxide emission in Poland fluctuates in time periods. But over 300 million Mg of this gas is emitted to the atmospheric air every year. In USCB, almost all methane emission comes from underground mining, but participation in CH₄ emission never exceeded 25% in reference to whole emission in Poland. It should be noticed that from 1994 to 2009 participation in emission (USCB to entire Polish territory) increased by 8 % and remain on the same level.

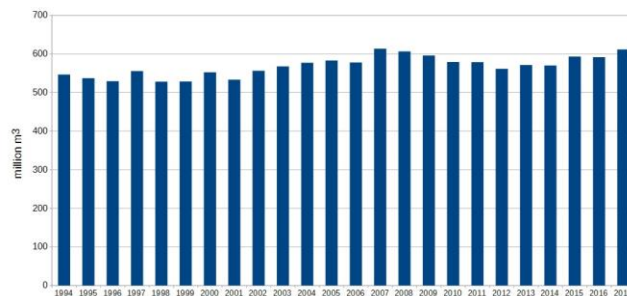


Figure 1. Carbon dioxide emission in Poland

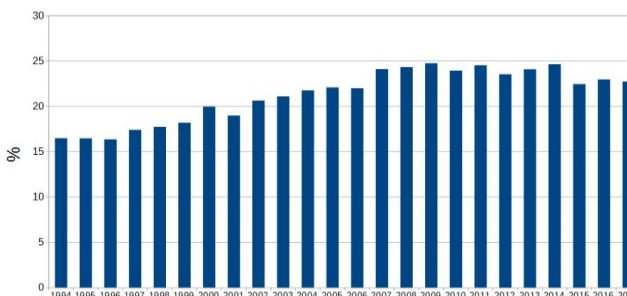


Figure 2. Ventilation Air Methane emission (VAM) in the USCB

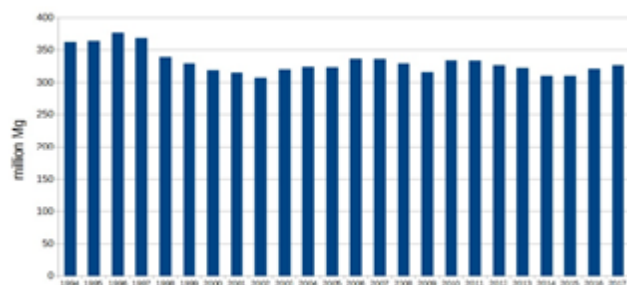


Figure 3. Percentage participation of methane emission in the USCB to the entire Polish methane emission

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