

Estimate of greenhouse gas emissions during coal production

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Abstract. The paper discusses the categories of greenhouse gas emissions associated with coal mining enterprises activities. The features and quantitative assessment of greenhouse gas emissions are also considered on the example of a coal mining enterprise. Recommendations are provided for reducing greenhouse gas emissions at coal mining enterprises.

1 Introduction

Anthropogenic greenhouse gas emissions are one of the most significant environmental problems of our time, capable to affect the Earth's climate system, leading to adverse environmental consequences [1].

2 Analysis

The main categories of greenhouse gas emissions sources associated with coal mining enterprises activities include:

- Emissions from stationary combustion of fuels - a category of greenhouse gas emissions sources which includes CO₂ emissions into the atmosphere resulting from all types of fuel combustion for the purpose of electrical and thermal power generation.
- Emissions from fuel combustion by transport - a category of greenhouse gas emissions sources, including CO₂ emissions from the combustion of gasoline and diesel fuel for passenger and cargo transportation by transport and other types of vehicles.
- Fugitive emissions – emissions during technological operations occurring during underground coal mining (associated gases during coal seams degasification and coal mines ventilation), as well as methane emissions from coal stocked in warehouses and during its transportation, as well as during implementation of other technological operations.

The amount of greenhouse gas emissions at coal mining enterprises is determined by the mining and geological conditions of mining, the gas content of the developed coal seams, the efficiency of using fuel resources in auxiliary industries, as well as by the climatic and meteorological characteristics of the region in which the enterprise is located.

An objective assessment of the impact of the coal mining industry and its contribution to global climate change processes is impossible without objective and reliable information.

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In accordance with the comprehensive plan for the implementation of the Climate Doctrine of the Russian Federation, it is recommended to strengthen climatic activities, which implies a more active reduction of greenhouse gas emissions, the introduction of low-carbon technologies and adaptation to climate change.

The developed, implemented and already existing methods of limiting the greenhouse gases content in the Earth's atmosphere are based on the quantification, monitoring, reporting and verification of greenhouse gas emissions.

To fulfill the Climate Doctrine provisions and to minimize the negative impact of coal mining, it is necessary to develop optimal strategies for adjusting technological solutions aimed at stabilizing the environmental situation in the industrial sites and in adjacent territories.

The coal mining industry is the main source of methane emissions into the atmosphere. The underground coal mining process is accompanied by coal mine methane release. Methane is the main greenhouse gas emitted during coal mining (about 90%). Reducing coal mine methane emissions contributes to a significant reduction of greenhouse gas emissions.

To determine the amount greenhouse gas emissions, as a result of production processes at the coal mine A, an inventory of greenhouse gas emissions was carried out. The Figure 1 provides information on the amount of direct greenhouse gas emissions changes from the mine A by category during 2014–2019.

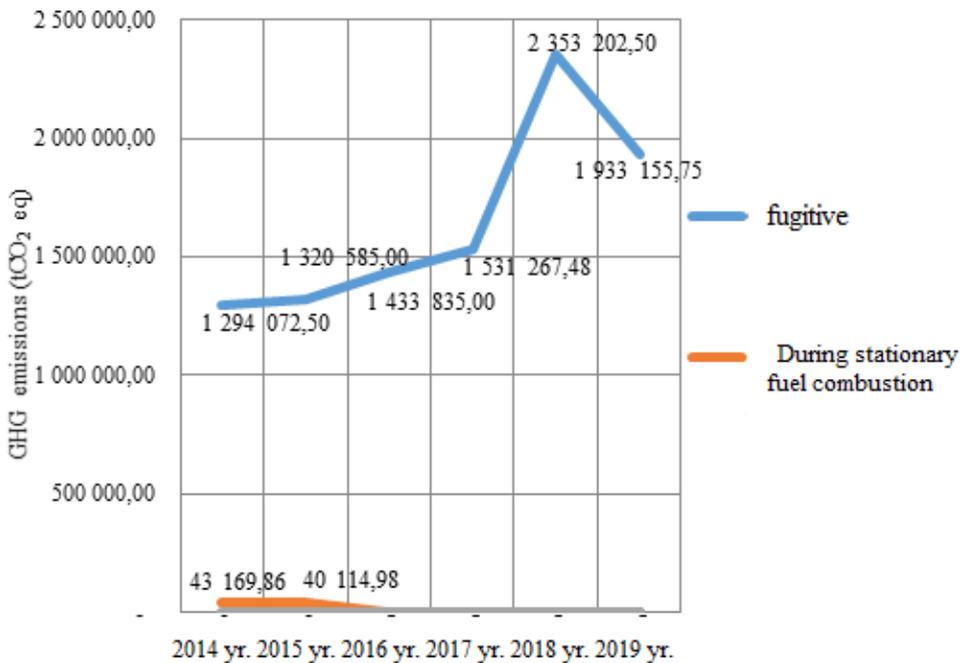


Fig. 1. Amount of direct greenhouse gas emissions at mine A by category during 2014–2019.

In 2018 a sharp jump in fugitive greenhouse gas emissions was observed. This is due to the fact that, with 2017 comparison, the amount of coal mined by the mine A in 2018 increased, and by 2019 it has decreased significantly again, which was envisaged by agreed plans of mining operations development.

The amount of greenhouse gas emissions from stationary fuel combustion amounted to 40,114.98 tCO₂e in 2015yr., which is 3,054.88 tCO₂e less than in 2014 yr. (43,169.86

tCO₂e). Since 2016 yr., coal fuel at mine A was consumed by an air heating unit (MTEU VNU) and by two boiler houses aimed for mine shafts heating which were removed from the mine balance and did not belong to it. Thus, CO₂ emissions from coal stationary combustion at mine A for the period 2016–2019 yr. were not considered by the mine.

Coal mine A does not have its own transport, therefore, GHG emissions from fuel combustion by transport were also not considered.

The maximum amount of greenhouse gas emissions at mine A falls within the category of fugitive emissions - 99.2%, with stationary combustion, greenhouse gas emissions constitute 0.8%. It can be concluded that degas methane, as the GHG gas, has the greatest potential for reduction at coal mines.

To reduce or stabilize greenhouse gas emissions at mine A, partial methane utilization is envisaged. For this, it is possible to re-equip the existing coal-fired boiler houses to use degasification. It is also feasible to consider methane utilization in gas generating units to generate thermal and electrical power [3-7].

3 Conclusion

Key recommendations for coal mining enterprises relating to production development, and GHG emissions reduction include:

1. Study the possibility of coal mine methane utilization recovered from coal seams:
 - 1.1. Geological and ecological study of the coal massif
 - 1.2. System development to record gas content of coal seams.
2. Approbation of technologies for using coalbed methane as fuel:
 - increase the number of power units fueled by coal mine methane (CMM) to generate heat and / or electricity;
 - use CMM as feasible source to fuel vehicles.
3. Development and implementation:
 - energy efficient technologies for mining, loading, transportation of minerals;
 - technologies for increasing the efficiency of degasification;
 - technologies for the use of secondary energy resources.

The measures proposed for coal mining enterprises will ensure an increase in the carbon intensity index and reduce the anthropogenic impact on the environment.

Let us consider the estimate of economic efficiency of the project for CMM utilization in a block-modular boiler house with a capacity of 3 MW to generate thermal power. The cost of 1 Gcal is accepted at the level of a one-part tariff of 1,200 rubles / Gcal.

Thus, the total amount of earnings from project realization due to thermal power generation will amount to 16, 798 thousand rubles. in year. Savings on payments for methane emissions into the atmosphere are not taken into account, but this will only improve the indicators of the project's economic efficiency. When calculating project revenues and project economic performance indicators, potential revenues from the sale of emission reduction units are also not taken into account. Implementation of CMM utilization projects will reduce greenhouse gas emissions, which include coal mine methane.

The total annual operating costs for the boiler house maintenance will amount to 10,850 thousand rubles, including the salaries for the main and auxiliary personnel, materials and components, as well as depreciation deductions. The project implementation will be accompanied by tax payments to the budget in the amount of 17,804 thousand rubles within 5 years. The size of the annual project profit from CMM utilization in the boiler house will amount to 11,585 thousand rubles over a period of 5 years. The main indicators for assessing the economic efficiency of the project are shown in the Table 1.

Table 1. Main indicators for assessing the project economic efficiency.

Indicator name	Indicator value
Capital costs (thousand rubles)	27 500
Payback period (PBP) (years)	3.4
Net present value (NPV) for 5 years (thousand rubles)	11 295
Internal rate of return (IRR) (%)	13.4
Investment profitability index (PI (coefficient))	1.41

In the future, it is possible to consider the option of re-equipping the existing coal-fired boiler station at a coal mining enterprise to use coal mine methane and to assess the economic efficiency of such a project.

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