GŁÓWNY INSTYTUT GÓRNICTWA

Journal of Sustainable Mining
e-ISSN 2300-3960 | p-ISSN 2300-1364

JOURNAL HOMEPAGE
jsm.gig.eu

The online version of the *Journal of Sustainable Mining* is the primary reference version of the journal

Burchart-Korol D., Krawczyk P., Czaplicka-Kolarz K., Turek M., Borkowski W. (2014). Development of sustainability assessment method of coal mines. *Journal of Sustainable Mining, 13*(4), 5–11. doi: 10.7424/jsm140402

ORIGINAL PAPER

Received: 22 September 2014 **Revised**: 3 November 2014 **Published online**: 2 December 2014

DEVELOPMENT OF SUSTAINABILITY ASSESSMENT METHOD OF COAL MINES

Dorota Burchart-Korol[1*], Piotr Krawczyk[1], Krystyna Czaplicka-Kolarz[2], Marian Turek[2], Wojciech Borkowski[1]

[1] *Department of Energy Saving and Air Protection, Central Mining Institute (Katowice, Poland)*
[2] *Central Mining Institute (Katowice, Poland)*
[*] *Corresponding author: dburchart@gig.eu, tel.: +48 32 259 26 97, fax: +48 32 259 22 67*

ABSTRACT

Purpose	This paper presents an algorithm developed to assess all aspects of sustainable development for hard coal mines. Additionally, an algorithm to assess the environmental efficiency and cost efficiency of mining production processes was presented.
Methods	To develop the computation algorithm, detailed models were proposed for environmental assessments using Life Cycle Assessment (LCA), whereas Cost-Benefit Analysis (CBA) was proposed for economic and social assessments.
Results	The algorithm developed is used when preparing a ranking of hard coal mines which considers the main aspects of sustainable development – environmental, economic and social. The tool also enables the performance of both environmental and cost assessment for particular unit processes of mining production.
Practical implications	The practical purpose is to devise an algorithm that will perform both partial and aggregated assessment of all aspects of the sustainable development of coal mines in Poland.
Originality/ value	It is the first method which includes all aspects of sustainable development and considers the process approach to assess coal mines.

Keywords
sustainability, hard coal mine, Life Cycle Assessment, Cost-Benefit Analysis

1. INTRODUCTION

Hard coal mining is the foundation of Poland's economic development. Coal plays a key role in providing Poland's energy safety. In the forecast of the demand for fuel and energy it is predicted that, in the near future, there will be no significant changes in the structure of raw materials used to produce electricity in Poland. According to Poland's Energy Policy 2050, coal will remain the main source of energy. Poland is one of the ten biggest producers of coal in the world (Table 1).

Table 1. Main producers of coal, 2012 (IEA, n.d.)

Producers	Mt	% of world total
People's Republic of China	3 549	45.3
United States	935	11.9
India	595	7.6
Indonesia	443	5.7
Australia	421	5.4
Russian Federation	354	4.5
South Africa	259	3.3
Germany	197	2.5
Poland	**144**	**1.8**
Kazakhstan	126	1.6
Rest of the world	808	10.4
World	7 831	100.0

The main aim of this paper is to develop an algorithm that will assess all aspects of sustainable development for hard coal mines and the environmental and cost efficiency of mining production processes.

2. SUSTAINABLE DEVELOPMENT IN COAL MINES

2.1. Assessment of sustainable development – state-of-the-art

In 1987 the World Commission on Environment and Development (Brundtland Report, 1987) at the United Nations (UN) defined sustainable development (SD) as *Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.* UNEP's Life Cycle Initiative in cooperation with the Society of Environmental Toxicology and Chemistry (SETAC) promotes Life Cycle Management (LCM) as an indicator of sustainable development, through combining the environmental assessment of a life cycle, the social assessment of a life cycle and the costs of a life cycle (UNEP/SETAC, n.d.). Burchart-Korol presented in the paper (2011) a review of complex assessment methods of sustainable development and a potential application of Life Cycle Sustainability Assessment (LCSA) and Socio-Eco-Efficiency

Analysis (SEEbalance). Applying Life Cycle Perspective (LCP) to the three basic pillars of sustainable development enables the incorporation of the issue of sustainable development in the decision making process. LCP means considering the aspects (environmental, economic and social) associated with the product throughout its life cycle (from extracting raw materials, through to processing materials, production, distribution, exploitation, repairs and maintenance, utilization and recycling) and in the value chain.

Indicators of sustainable development are basic monitoring tools, which enable the visualisation of the very essence of the concept in a measurable form. In recent years the importance of sustainable development has been steadily growing, especially when considering environmental issues associated with climate warming. As a result of the global effects of environmental problems, increasing ecological awareness, as well as more and more restrictive and complex environment protection legislation, the conditions of operating business activities changes too – especially in the power industry sector. That is why in the following years it will be more and more necessary to take actions aimed at reducing the emission of greenhouse gases, which result from the present problems of global climate changes. Czaplicka-Kolarz, Krawczyk, and Burchart-Korol (2013) identified factors of underground coal gasification influencing balanced Life Cycle Assessment, and they also attempted to assess the influence of implementing underground coal gasification technology on the indicators of sustainable development in Poland.

2.2. The importance of sustainable development aspects in hard coal mines

Issues of sustainable development are also reflected in strategies and action plans of the hard coal mining industry, and these issues play an important role in setting aims and priorities associated with the long-term development of Poland and its ability to follow the rules of sustainable development.

As Poland implements the European Union regulations concerning issues of environmental protection, coal mines ought to meet conditions concerning using the environment which are specified in relevant decisions and administrative permits. Environmental protection is a European Union priority. That is why such an important issue for coal mines is following the requirements associated with coal production. As far as environmental protection is concerned, one of the priorities in the strategy of coal mines is obtaining specific volumes of hard coal production whilst having a minimal negative impact on the environment. The aim of the Polish state's policy towards the hard coal mining industry is the rational and effective management of coal deposits located in the territory of the Republic of Poland, so that the deposits serve the generations to come.

Mining activity is associated with negative influence on the environment (Bednorz, 2011). Preventing significant environmental impact is becoming more and more important for coal mines. Coal mines implement Environmental Management Systems and develop environmental protection strategies. The main environmental aspects of coal mines in Poland are: mine waters, mining waste and methane emission into the atmosphere, thus the priorities for environmental protection are:

- preventing the generation of waste other than those from mining, including hazardous waste,
- limiting the amount of mining waste, through the better management of waste on the surface and in underground workings,
- expanding the scope of reclamation and better management of mining waste heaps and other areas degraded by mining activity – restoring the utility value of degraded areas,
- minimizing the influence of mining activities on the surface by operating mining activities in a way that limits deformation of the surface and through wider use of prevention measures,
- decreasing the impact of waste water, especially water with abnormal salinity from dewatering coal mines, on surface water,
- decreasing the emission of dust and gas pollution into the atmosphere, especially reducing the emission of greenhouse gases,
- limiting the use of energy,
- the efficient collection of methane released from the rockmass to minimize its emission into the atmosphere, as well as preventing methane hazards underground to provide safe working conditions,
- to continuously increase the economic use of methane drained and brought to the surface,
- reducing noise emission into the environment.

Some examples of the application of life cycle assessment in the mining industry can be found in the literature (Durucan, Korre, & Munoz-Melendez, 2006; Awuah-Offei & Adekpedjou, 2011). Work associated with the environmental assessment and economic assessment of mining investments has been conducted for many years both in Poland and around the world. It was concluded that the work associated with assessing the efficiency of coal mines refers to separate issues, these being: economic, environmental and social, without providing a common approach which would enable the assessment of all the aspects of sustainable development. It has also been concluded that at present there are no complex analyses concerning the application of costs and benefits analysis methodology which would also consider non-financial costs and the benefits of running mining activities in Poland. Krawczyk, Majer, and Krzemień (2014) presented the possibilities of applying costs and benefits analysis to calculate the eco-efficiency of coal mines in Poland. Mishra, Sugla, and Singha (2013) presented factors which influence the productivity of coal mines. Salii (2011) presented methods of economic assessment of a coal mine which are used in Ukraine. The aforementioned methods employ such indicators as: economic attractiveness and economic credibility, which are an aspect of the technical conditions, geological and mining conditions, organizational conditions and economic conditions of coal mines.

Based on the literature review it was concluded that hitherto works concerning the efficiency of coal mines (including environmental, economic and social efficiency) do not consider the process approach.