

# **Functioning of the Local Production Systems in Central and Eastern European Countries and Siberia**

**Case Studies and Comparative Studies**

**Edited by  
Mariusz E. Sokołowicz**



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Mariusz E. Sokołowicz – University of Łódź, Faculty of Economics and Sociology  
Institute of Spatial Economics, Department of Regional Economy and Environment  
90-214 Łódź, 36 Rewolucji 1905 r. St.

REVIEWER

*Adam Polko*

PUBLISHING EDITOR

*Bogusława Kwiatkowska*

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e-mail: [ksiegarnia@uni.lodz.pl](mailto:ksiegarnia@uni.lodz.pl)

tel. (42) 665 58 63, faks (42) 665 58 62

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*Yuliya Tsvlodub\**

## **COAL MINING AREAS: ENVIRONMENTAL ISSUES AND SOLUTIONS (ON THE EXAMPLE OF KUZBASS)**

### **1. Introduction**

The coal industry was and remains one of the basic sectors of the Russian economy. Although formally the coal industry's share in the GDP is slightly above 2%, specialists and experts believe that the actual contribution of coal to the economy is much higher than expressed in percentage of GDP. Speaking about coal as one of the elements of sustainable development of the national economy, the importance of coal for other industries cannot be overstated. In fact, coal is one of the elements forming the final product of metallurgy, it has a significant share in the railways' freight turnover (40%), it is a source of raw material for the chemical industry and the energy production (power stations).

Having survived restructuring period during which the volume of product halved, since 1999 the industry has seen a significant growth of its production. Analyzing the current state of the Russian coal industry, it is possible to emphasize the following positive trends:<sup>1</sup>

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\* Senior Lecturer, Chair of Mathematical Methods for Economics and Planning, Novosibirsk State University.

<sup>1</sup> A. Tverdov, A. Zhura, S. Hikishichev, *Problemy i perspektivy razvitiya ugolnoy otrasli Rossii*, "UGOL" 2012, Vol. 8, p. 86.

- significant increase in production from 232 million tons in 1998 to 336 million tons in 2011;
- increase in labor productivity while reducing the workforce – from 88 tons/month in 1998 to 235 tons/month in 2011;
- growth of investments in the renewal of fixed assets and new plant – from 5.1 billion rubles in 1998 to 90 billion rubles in 2011;
- the share of coal exports in the total production increased from 10.2 in 1998 to 35.7% in 2011.

The main share of mined coal field in Russia is concentrated in the following basins: the Kuznetsk Basin, the Pechora Basin, the Irkutsk Basin, the Kansk-Achinsk Basin, the Moscow Region, the Eastern Donbass, the Tunguska Basin, the Lena Basin, the Kizelyovsk Basin. The largest of them – the Kuznetsk coal basin (Kuzbass) – is located in the Kemerovo Oblast (South of Western Siberia). It is one of the largest coal fields not only in Russia but also in the world (58 mines and 36 pits are operated here<sup>2</sup>). The total geological reserves of the basin are about 700 billion tons, including about 200 billion coking coal.<sup>3</sup>

It is appropriate to note that the Kemerovo oblast is one of the largest industrial regions of Russia. The basis of its industrial production includes coal mining and cleaning, iron and polymetallic ores extraction. Manufacturing industries of Kuzbass are mainly ferrous and nonferrous metallurgy, production of primary chemical products and building materials. In conjunction with energy production and construction industry, this set of industries dominate the economy of the region, making 57.7% of the GRP.<sup>4</sup> According to M. E. Porter,<sup>5</sup> regional cluster is defined as a group of geographically concentrated companies from same or related industries and supporting institutions located in a particular region, manufacturing

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<sup>2</sup> Ministry of Energy of the Russian Federation [official site], <http://minenergo.gov.ru/activity/coalindustry/coaldirection/982.html> (accessed 18.07.2013).

<sup>3</sup> The administration of the Kemerovo oblast [official site], <http://www.ako.ru/Kuzbass/polezn.asp?n=9> (accessed 18.07.2013).

<sup>4</sup> L. Elentseva, E. Volynkina, *Analiz vozmozhnostey dlya razvitiya otkhodopere rabatyvayushey otrasli v Kuzbasse s uchetom mirovogo opyta*, “Okhrana okruzhayushey sredy i prirodopolzovanie” 2010, Vol. 4, p. 40.

<sup>5</sup> M. Porter, *Konkurentsia*, Williams Publishing House, Moscow 2000, p. 207.

similar or complementary products and characterized by the presence of information exchange between the member firms of the cluster. Thus, Kuzbass can be considered as a kind of “natural” regional cluster.

For 15 years, coal production in Kuzbass doubled, exceeding planned targets. Thus, the Energy Strategy of Russia for the period up to 2030 envisages an increase in production in Kuzbass in 2030 to 201 – 205 million tons. However, already in 2012 the Kemerovo region produced 201.5 million tons of coal, including 52.2 million tons of coking coal and 149.3 million tons of steam coal (In 2011, these figures amounted to 48.8 million tons and 143.3 million tons respectively). At the same time, about 40% of coal production, manufactured in Kuzbass, is exported to more than 40 countries, it accounts for 80% of Russia’s coal exports. Coal extraction in 2012 reached an absolute historical maximum – such volumes had not been achieved in the region in the Soviet years. Today, the Kemerovo oblast produces 65% of Russia’s total coal and 75% coking coal volumes.<sup>6</sup> Coal production in Kuzbass is compared with production of the leading coal-producing countries, such as Germany (if one includes also the extraction of lignite in the latter), and is ranked seventh in the world.

A potential for further growth of coal mining is far from exhausted. For example, in 2013, the Kemerovo oblast will be put into operation three coal mines (“Butovskaya”, “Erunakovskaya-VIII”, “Karaylinskaya”) and two concentrating mills (concentrating mill “Cascade” and concentrating mill named after Kirov). Kemerovo oblast’s Governor Aman Tuleyev sees the future of the coal industry in vertically integrated structures: “My deep belief: the future is not in separate mines, pits, but in associations, clusters of enterprises that implement a full cycle, the entire production chain – from coal mining to its final processing”.<sup>7</sup> But at the same time, the head of the region said that the volume of coal mining would not increase. In the next few years Kuzbass will probably stabilize coal production at 200 million tons.

This is due to the fact that growth of coal has its limits both from economic and ecological points of view. The economic aspect is that the world coal prices are falling. In Europe coal is less attractive than gas, so Western

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<sup>6</sup> M. Kichanov, *Ugolnyy peregruz*, “Expert-Sibir” 2013, Vol. 4 (360), p. 11.

<sup>7</sup> M. Kichanov, *op. cit.*, p. 15.

European countries prefer to import gas. At the same time, the coal demand in China and India is sufficiently high. However, because of large distances and high transport tariffs, Russian coal finds it difficult to compete with that from Kazakhstan.

The environmental side of the issue is that the mining and processing of coal will inevitably cause serious environmental problems. Their solution requires a significant capital investment. This naturally leads to an increase in the cost of coal, which has a negative effect on the competitiveness of Russian coal on the world market.

## **2. Ecological situation in the coal industry**

The development of resource-intensive industries, including coal mining industry, entails significant environmental costs. Economic activity causes damage to environment producing emissions of gaseous pollutants in the atmosphere, liquid waste and solid waste. According to the Russian rating of branches of the economy as to the degree of waste emissions in the environment, in 2005 the coal industry took 6<sup>th</sup> place (by emissions) for gaseous waste (767.3 thousand tons), 9<sup>th</sup> in the liquid waste (413.8 million m<sup>3</sup>), 1<sup>st</sup> place in the solid waste (1442.9 million tons). The risk level of the coal industry is II (it means “very dangerous”).<sup>8</sup>

Moreover, it is possible to separate another serious problem of coal industry – withdrawal of lands from land use.

### **2.1. Emissions in the atmosphere**

The major sources of emissions of air pollutants at the enterprises of coal industry are coal-fired boiler, burning waste dumps, air emissions from mines, surface mining, operation of mining equipment. Particularly

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<sup>8</sup> Gosydarstvennyy doklad “O sostoyanii i ob okhrane okruzhayushey sredy Rossiyskoy Federatsii v 2007 godu”. Ministry of Natural Resources and Environment of the Russian Federation [official site], <http://www.mnr.gov.ru/regulatory/list.php?part=1101> (accessed 18.07.2013).



dangerous are gaseous substances: oxides of sulfur, nitrogen and carbon, methane, and volatile organic compounds. The largest share of total emissions of pollutants is represented by mine methane (up to 90%).<sup>9</sup>

The main problems in the preservation of the atmosphere in the coal industry are mine methane utilization, prevention of spontaneous combustion and burning of waste dumps, installation of purifying equipment at all stationary sources.

Extensive damage to health of the population of the miner's cities and settlements is caused by burning waste dumps, especially those close to them. Most of these emissions arrive in the atmosphere, bypassing gas-purifying installations. The greatest amount of pollutants emitted without treatment is in the Kuznetsk Basin (67.3% of the industry index).<sup>10</sup>

Degassing of coal seams prior to their exploitation and in the process of mining and extraction of methane gas from vent streams remain relevant and challenging scientific and technological problems that need to be resolved.

## 2.2. Sewage pollution

The situation with wastewater treatment in the coal industry is also unsatisfactory. Characteristic contaminants in mine and quarry waters include suspended solids, oil products, phenols, iron, heavy metals, and some trace elements. The main method of wastewater treatment plants in the industry is a mechanical way of using tanks and ponds, which in most cases does not provide treatment for the entire spectrum of contaminants in accordance with existing regulations. Other causes of inefficient operation of treatment facilities are exceeding the actual flow of treated water from their estimated capacity, poor technical conditions of the facilities, and violation of technological cleaning mode.<sup>11</sup>

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<sup>9</sup> B. Schadov, *Ecologicheskie problemy ugolnoy otrasli na zavershayuschem etape restrukturizatsii*, "UGOL" 2007, Vol. 6, p. 33.

<sup>10</sup> *Ibidem*.

<sup>11</sup> A. Litvinov, A. Kharitonovskiy, *Sostoyanie okruzhayushey sredy v ugolnoy promyshlennosti*, "UGOL" 2012, Vol. 10, p. 74.

As a result, the mass of pollutants released into water bodies is much greater than their self-cleaning ability. This leads to contamination of water bodies, which significantly restricts or eliminates their use in the national economy. Thus, more than 200 rivers in the Kuznetsk Basin have been put out from water use resulting from the disposal of mine and quarry water.<sup>12</sup>

### 2.3. Solid waste

As noted, the coal industry takes first place in the production of solid waste. It accounts for about two thirds of the total volume of all solid waste. Most of the accumulation is related to the hazard class V ("practically non-hazardous"). In addition, the extracted coals have become a source of accumulation of around a billion tons of solid waste from its customers.<sup>13</sup>

As a result of the industry's transition to a predominantly open pit coal mining has been continuous increase (from 4.2 to 6.1 tons or more) of the amount of waste per 1 ton of coal produced. In the coming years, according to the Energy Strategy of Russia the amount of waste produced each year could exceed 3 billion tons.<sup>14</sup>

The distribution of annual increase of waste corresponds to the location of the main coal basins of the Russian Federation in proportion to the volume of coal produced in them. Therefore, the dominant role in the formation of waste belongs to Kuzbass.

The emergent waste is hazardous for the environment and human health, disrupting the ecological balance. On the other hand, certain waste products represent economic value. Large economic effect can be obtained by using secondary resources instead of natural raw materials. Much of the waste is man-made or secondary resources which often successfully

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<sup>12</sup> B. Schadov, *op. cit.*, p. 32.

<sup>13</sup> V. Kazakov, S. Popov, I. Stoyanova, V. Kharchenko, *Metodologicheskie osnovy otsenki tsennosti uglepromyshlennyykh otkhodov dlya rasshireniya masshtabov ikh ispolzovaniya v khozyaystvennoy deyatel'nosti*, "UGOL" 2012, Vol. 4, p. 50.

<sup>14</sup> *Ibidem*.

compete with the natural resources.<sup>15</sup> The overburden and host rocks of pits and mines are very similar to common minerals in their qualitative composition and properties and this creates the preconditions for their industrial use.<sup>16</sup>

### 3. Environmental situation in Kuzbass

The environmental situation in Kuzbass in 1992 was defined as an emergency, and to date it has become worse. The area of the Kuznetsk Hollow, where there is a coal basin, is the most aggravated area. It includes the largest cities of the region – Novokuznetsk, Kemerovo, Prokopyevsk, Belovo, Leninsk-Kuznetsk, Tashtagol, Kiselevsk.

Methods of extraction and coal processing used in the Kuznetsk Basin resulted in substantial transformation of the environment. Pits and dumps formed as a result of human impact violated the natural landscape, the soil cover. This led to degradation of flora and fauna.

Coal processing contaminates surface water and the atmosphere. As a result, none of the rivers of the Kuznetsk hollow is suitable for drinking, although clean water comes to the hollow from the mountains. In 2010, such enterprises as OJSC “SUEK-Kuzbass”, JSC “MC” Southern Kuzbass, JSC “TQM” “Juzhkuzbassugol”, JSC “Severnny Kuzbass” accounted for 43% of the volume of contaminated wastewater of the coal industry.<sup>17</sup>

The situation is exacerbated by the geographic location: Kuznetsk Basin is surrounded by the Mountain Shoria in the south, the Kuznetsk Alatau in the east and the Salair Ridge to the west. It leads to the fact that harmful substances cannot bypass mountains, concentrating exclusively in Kuzbass. As a result, Novokuznetsk, Kemerovo and Prokopyevsk are the cities of the Kemerovo oblast which have the highest level of air pollution.<sup>18</sup>

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<sup>15</sup> L. Elentseva, E. Volynkina, *op. cit.*, p. 40–42.

<sup>16</sup> B. Schadov, *op. cit.*, p. 31–36.

<sup>17</sup> A. Litvinov, A. Kharitonovskiy, *op. cit.*, p. 74.

<sup>18</sup> Gosydarstvennyy doklad “O sostoyanii i ob okhrane okruzhayushey sredy Rossiyskoy Federatsii v 2011 godu”. Ministry of Natural Resources and Environment of the Russian Federation [official site], <http://www.mnr.gov.ru/regulatory/list.php?part=1101>, p. 259 (accessed 18.07.2013).

Emissions from stationary sources in Kemerovo oblast were 1,390 thousand tons in 2011 (by 1.5% less than in 2010). The main stationary sources of air pollution in the region are OJSC “EVRAZ Consolidated West-Siberian Metallurgical Plant”, OJSC “West-Siberian Metallurgical Plant”, JSC “TQM” “Juzhkuzbassugol”, Branch of Mine “Esaulskaya”, they had a share of 21% in total emission of pollutants into the air from stationary sources. Emissions from mobile sources (vehicles) accounted for 13.9% of gross emissions in the region.<sup>19</sup>

Kuzbass is the first in Russia in the amount of waste: 1.8 billion tons per year with the total in Russia of 3.9 billion tons. The bulk of waste is due to the activity of the coal industry (1694.36 million tons, or 98.36%), a significant amount of waste produced in the ferrous and non-ferrous metallurgy (25.16 million tons or 1.46%), in the production and distribution of electricity, gas and water (2.71 million tons or 0.16%), and in the chemical industry (0.172 million tons or 0.01%).<sup>20</sup>

Over the past 10 years there was a growth of waste. In 2002 the mass of waste generated in the region amounted to 1.0 billion tons, in 2006 this figure increased to 1.9 billion and decreased to 1.76 billion tons in 2009 as a result of the industry downturn due to the economic crisis.

The bulk of the waste (99.4% of the total) belongs to V hazard class (practically non-hazardous), of which more than 90% are stripping and host rocks. 54% of generated waste are used and disposed.<sup>21</sup> About 1 billion tons of waste per year is not utilized and stored.<sup>22</sup> The rest of the waste is placed in external waste dumps.

The main ways of waste production use are filling out pits and holes, construction (surface planning, road embankment, dams building, etc.), building materials (brick, concrete, crushed stone, etc.). Waste of I – IV danger class is not specific to the coal industry, as a rule it is transferred to specialized institutions for disposal or placement in special landfills industrial waste.

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<sup>19</sup> *Ibidem*.

<sup>20</sup> L. Elentseva, E. Volynkina, *op. cit.*, p. 41.

<sup>21</sup> B. Schadov, *op. cit.*, p. 34.

<sup>22</sup> L. Elentseva, E. Volynkina, *op. cit.*

In the Kemerovo oblast there are about 3,000 registered waste disposal facilities, occupying an area of over 40 hectares, with a total accumulation of more than 20 billion tons.<sup>23</sup> A large mass of waste is not processed, and stored in dumps, sludge pits and ponds of processing plants, providing an enormous impact on the environment. The intensification of mining in the region will further increase the amount of waste.

It is necessary to emphasize that the largest volume of generated waste is due to the activities of the coal enterprises of the Kemerovo oblast, namely of JSC MC “Kuzbassrazrezugol” (Prokopyevsk region), JSC MC “Southern Kuzbass” (Mezhdurechensk), JSC “Pit Vinogradovsky” (Belovo region), JSC “Chernigovets” (Berezovsky), JSC “Mezhdureche” (Mezhdurechensk), OJSC “SUEK-Kuzbass” (Leninsk-Kuznetsk).<sup>24</sup>

Exploitation of coal fields in Kuzbass is carried out both underground and in the open way. Moreover, in recent years preference is given to the most effective and safe method to exploit coal deposits – the open way, that is accompanied by construction of heavy-duty pits. Their construction and operation requires solving a set of problems that affect the efficiency and safety of coal mining complexes.

The main tasks of the optimization process of waste management as identified by specialists<sup>25</sup>:

- reduction of waste production, primarily of overburden and host rocks on the pits by improving the technology of overburden and mining operations;
- selective mining and stockpiling of overburden and host rocks with a view to their subsequent utilization;
- increase of waste processing volumes to produce marketable products through creation of relevant industries;
- increase transfer of utilization to specialized organizations.

Waste management industry can be considered as one of the most effective ways to diversify the economy of Kuzbass.

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<sup>23</sup> Yu. Proshutin, A. Poturilov, *O perspektivakh ispolzovaniya tekhnologii podzemnoy gazifikatsii kamennykh i burykh ugley v kachestve instrumenta dlya snizheniya ob'ema tekhnogennykh otkhodov*, “Okhrana okruzhayushey sredy i prirodopolzovaniye” 2011, Vol. 1, p. 43.

<sup>24</sup> Gosydarstvennyy doklad “O sostoyanii i ob okhrane okruzhayushey sredy Rossiyskoy Federatsii v 2011 godu”..., p. 260 (accessed 18.07.2013).

<sup>25</sup> B. Schadov, *op. cit.*, p. 35.

#### 4. Problem of land withdrawal in Kuzbass

One of the main factors disturbing the ecological balance of natural systems in areas where are coal enterprises placed, is the removal of lands from the economic land use to accommodate industrial areas, waste dumps, sludge storage, access roads, communication lines and other industrial facilities and land disturbance by mining activities. Land disturbance occurs primarily in the open way by expanding the scope of work and use of land for external waste dumps. By 2001, the total area in Kuzbass, disturbed only by open-pit mining, accounted for 8% of the total area of the region.<sup>26</sup> Overall, the share of Kuzbass has 67.5% of disturbed lands throughout the coal industry.<sup>27</sup>

The problem of land violation in the Kuzbass is exacerbated by high concentration of mining and proximity of coal mines to residential areas. There are places where sections of open-pit mining alternate or are on some planes with coal mining. This is the case, for example, in the areas of Prokopyevsk and Kiselyovsk.

Annually parts of the disturbed land are excluded from the production process and pass to the category of waste lands. Many companies have considerable areas of waste land that are not involved in the production process and are subject to rehabilitation.

At open mining operations there is destruction of natural landscape, vegetation and soil cover is destroyed. Man-made dump and quarry landscape is an alternation of pits of various depth (to 100 m) and overburden dumps of different shape and size: many-tier dumps, cone-shaped or ridge-shaped deposit tips of tens meters in height.<sup>28</sup> The considerable spaces are occupied by sludge ponds.

The constant increase in specific weight of open method of total coal mining and increasing stripping ratio lead to augmentation in the volume

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<sup>26</sup> L. Khoroshilova, A. Tarakanov, *Problemy narushennykh zemel v Kuzbasse i ikh puti resheniya*, "Vestnik Kuzbasskogo gosudarstvennogo tekhnicheskogo universiteta" 2007, Vol. 2, p. 63.

<sup>27</sup> A. Litvinov, A. Kharitonovskiy, *op. cit.*, p. 77.

<sup>28</sup> L. Khoroshilova, A. Tarakanov, *op. cit.*, p. 63.

of overburden and as a result to growth of waste production and an extension of the areas of disturbed lands.

Much of the waste is used for internal dumps formation, filling up holes, remediation of mining and quarrying, relatively small part of wastes is used as construction and building materials. Unused rock is mainly located in external dumps, which occupy large areas and are a constant source of anthropogenic impact on the atmosphere, groundwater and surface water, soil land in the adjacent territory.

Underground mining leads to formation of undermined territories. The nature of surface damage from underground coal mining depends on depth, power and angle of incidence of coal seams, structure of coating thickness, and mining technology. At underground mining operations there is a formation of holes, cracks and craters, as well as subsidence of land above the mine. On a part of the work area some soil cover remains, but these lands are in most cases excluded from agricultural or forestry use, as after operations the hydrological regime of the territory changes drastically: groundwater disappears, and atmospheric precipitations quickly seep deep into cracks.

On the other hand, many coal mines have implemented drained fields which led reducing the length of rivers and drained the affected area. Thus, Kuzbass mining operations destroyed more than 200 small rivers, and the process is accompanied by vegetation degradation, up to shrinkage of the forest.<sup>29</sup>

One of the most commonly used ways to eliminate unprofitable mines is flooding. As a result of quick restructuring of the coal industry in Kuzbass in a number of mining towns, standing in the flooded mines, there is a constant threat of collapse of areas and roads, destruction of buildings. They have constantly flooded cellars and basements; from the land gas is emitted squeezed out of the flooded mines. Bogs with a total area of 12 hectares have formed on a number of waterlogged areas in the city of Kemerovo.<sup>30</sup> A more promising way environmentally and economically is not flooding of mines (i.e., in fact, liquidation), but their conservation.

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<sup>29</sup> *Ibidem.*

<sup>30</sup> *Ibidem.*

Restoration of disturbed lands and natural landscapes includes a complex of mining, farming and other activities aimed at the restoration of their biological productivity and economic value.

In conditions of high land fee reduction of specific land costs of mining, increase in volumes and improvement of quality of land remediation works are economically important, and, of course, require more attention.

A necessary measure to reduce environmental damage to the nature of the activity of mines and quarries is land recultivation. Cultivation works are carried out in Kuzbass, but their rates are low. To date only about 20% of disturbed lands are reclaimed. In addition to severe geological conditions of the Kuzbass basin (multilayer structure of coal deposits, a large depth, mostly external dumps formation and high specific land costs of coal mining), the lack of a regional legislative base for the reclamation, which has forced mining companies to restore damaged land, influences rates of reclamation. Existing state standards which are based on the existing methods of restoration of disturbed lands have not been revised since 1986.

The coal mining enterprises have negative impact on all main components of the environment, causing their unfavorable changes. Natural landscapes are violated and degraded, water bodies, air and soil cover is polluted in solid, liquid and gaseous contaminants. The development and introducing clean, low-waste and non-waste technologies is occurring by slow rates. The industry is trending toward a reduction of investment in environmental protection, which leads to a number of negative consequences: an extremely small amount of construction of wastewater treatment plants, dust and gas cleaning plants and other facilities for nature protection purposes, the slow update and as a result obsolescence and high degree of wear of environmental protection equipment. Imperfection of the environmental legislation, the country's system of pollution payment, and environmental disturbance lead to decreased volume and efficiency of nature protection activities.

Further sustainable development of the coal industry is inseparably linked with the problem of ensuring environmental safety of production and preservation of a favorable environment for the population, especially in the areas of compact allocation of companies.



## 5. Measures for enhancement of environmental situation

Continuation of the current trend might lead to a sharp aggravation of ecological and as a consequence, social situation in the coal-mining regions. As we discussed above, the directions of improving the environmental situation in the coal industry, in particular, on the territory of Kuzbass are the reduction of emissions and dumping of pollutants and volumes of waste production, the ecologization of manufacturing processes aimed at reducing specific land costs of mining.

To solve the complex of environmental issues it is necessary to raise environmental performance to a new qualitative level. That will require more investment in environmental protection, their volume should be increased by at least one order of magnitude.<sup>31</sup>

The projects of construction and reconstruction of the coal enterprises should be provided a full range of environmental activities to ensure compliance with current regulatory requirements for the protection of ecological environment, the ecological safety of production, and favorable environment for the population of the miner's cities and settlements. For the whole territory of Kuzbass it is necessary to develop and introduce monitoring natural and technical coal-mining complexes.

It should provide introduction of certified environmental management systems and environmental audit in accordance with international standard ISO 14001, establishment at each enterprise of effective system of environmental control of production.

### 5.1. Water and air

The emissions polluting air and water have a serious negative impact on human health.

The main objectives of the coal industry in the field of protection of water resources and the atmosphere are the construction and reconstruction of treatment

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<sup>31</sup> M. Kichanov, *op. cit.*, p. 11–15.

facilities based on a new technological basis, improving technical conditions and improving the efficiency of existing facilities, in particular, the modernization of inefficient wastewater treatment plants, dust and gas cleaning systems, aspiration systems and other environmental structures and equipment to ensure standard cleaning of industrial discharges and emissions. For sewage discharged into water bodies without treatment, it is necessary to provide renovation and construction of facilities or transfer these water objects to existing treatment facilities of other companies. Control over the impact on the environment should be carried out by means of systems of tool control of the impact on the environment. To diagnose treatment plants of sewage effluent and gas treatment installations enterprises have to attract specialized companies that make the conclusion about the reasons for their poor performance and make recommendations for their modernization, reconstruction, construction of new facilities and the replacement of outdated gas cleaning plants.

One of priority activities of enterprises to improve environmental safety is degassing of coal seams prior to their processing and in the process of mining, utilization of methane as a source of electricity and thermal energy.

Priority is also conducting ongoing efforts to extinguish the burning of waste dumps and measures to prevent their spontaneous combustion.

## 5.2. Solid waste

There is a problem of solid wastes of the coal industry, which are, on the one hand, man-made accumulation of various mineral resources, on the other hand, are a source of negative impact on the environment.

The practice of using mineral resources of separate accumulation of coal-mining waste began in the first half of the last century. At the same time, despite the increased importance of waste, mainly related to the depletion of natural deposits and their remoteness, most of them remained unclaimed. Of all the waste of the coal industry to create marketable products used only 3% of the volume.<sup>32</sup>

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<sup>32</sup> V. Kazakov, S. Popov, I. Stoyanova, V. Kharchenko, *Metodologicheskie osnovy otsenki tsennosti uglepromyshlennyykh otkhodov dlya rasshireniya masshtabov ikh ispolzovaniya v khozyaystvennoy deyatel'nosti*, "UGOL" 2012, Vol. 4, p. 50.

Currently there are known about 60 technological decisions on the use of wastes as mineral resources in the production for the construction industry, agriculture, metallurgy, ceramics, paint industry, chemical industry, consumers of secondary fuel resources, etc. However, only a third of their part tested in practice, while the other two-thirds remain only potentially possible.<sup>33</sup>

At the present stage of development of Russia production of various kinds of mineral resources from the waste in the coal industry, as a rule, can be a collateral activity. Involvement of solid waste in economic activity may present a great interest from both an economic and an environmental point of view. It is necessary to develop and widely to use technology of reusing and recycling of waste; to develop and apply modern techniques of utilization and burial of hazardous wastes.

### 5.3. Land recultivation

Along with the problem of solid waste disposal, the problem of land rehabilitation is not solved, in particular, rates of recultivation are on the order behind the needs of the region.

Elimination of the negative environmental effects of many years of industrial activity (closed mines and quarries) requires a long period to develop detailed designs and implement measures to prevent flooding undermined areas, rehabilitation of industrial sites, waste dumps, cleaning poured on the surface of contaminated mine water, etc. The projected significant environmental effect from liquidation of unprofitable enterprises can be achieved only after the full implementation of environmental protection measures provided by projects of liquidation.<sup>34</sup>

Solving problems of land, arising in the coal industry, consists in carrying out large-scale measures for the rehabilitation of disturbed areas, which should be started after the end of development of coal pit or mine. The complex of these activities includes the restoration of soil fertility, cleaning of rivers, the creation of forest parks, shelterbelts and recreation areas. There have to be especially protected areas to preserve a biodiversity of environment.

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<sup>33</sup> *Ibidem*, p. 50–51.

<sup>34</sup> B. Schadov, *op. cit.*, p. 31–36.

The task is to embed the mining companies in the ameliorated landscape and by that to preserve the biological diversity of the region. Positive examples are emerging<sup>35</sup>: in the spring of 2012 a new specially protected area was presented in the Belovo area – wildlife sanctuary “Karakansky”. This complex appeared in an industrial area where there is an intensive coal mining, thanks to the decision of the Kuzbass Fuel Company to reconsider its plans to develop the area. The assignment of about 1,200 hectares allowed the authorities to take under protection a unique natural complex – Karakansky ridge, which is distinguished by richness and diversity of flora and fauna.

#### **5.4. New methods and technology**

The next way to improve the coal industry is to elaborate and implement programs for the development of the main production, improvement of technology and technological processes in enterprises taking into account ecological requirements.

Speaking about the industry and its prospects, it is necessary to point to a considerable potential for further development, including the progressive transition to the deep processing of coal with production of marketable products of high added value. The direction of increasing the share of coal undergoing deep processing is quite promising and includes: the transition to the enrichment of all export coal, substitution of coking coal concentrate exports by exports of coke (within certain limits based on market conditions), the production of synthetic liquid fuels and synthetic gas, production of a wide range of chemical products (polymers, etc.) in the processing of coal; generation of electric and thermal energy from the coal, including for export, extraction of high value components from coal and its products.<sup>36</sup>

Another technological direction is the gasification process. According to a number of experts, the technology of underground coal gasification (UCG) it is capable to compete with modern technologies of the open pit and mine. In the Soviet Union in the 30s of the last century, intensive theoretical and experimental studies formulated the basic principles of this technology on the basis of which some pilot plants for underground gasification were commissioned

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<sup>35</sup> M. Kichanov, *op. cit.*, p. 14.

<sup>36</sup> A. Tverdov, A. Zhura, S. Hikishichev, *op. cit.*, p. 86–88.

and operated successfully for a number of years, even decades. In total at these stations there were more than 15 million tons of coal and generated more than 50 billion cubic meters of gas. One of such stations – South-Abinskaya station “Podzemgaz” – functioned from May 1955 to 1996.<sup>37</sup>

As the advantages of the process of UCG experts note the following: obtaining tangible effect in the energy supply of industrial areas in the event of a large-scale use of UCG technology, the lack of waste associated with traditional methods of coal mining and coal preparation; the exception of heavy, harmful and dangerous work of miners in underground coal mining; replacement of costly and unsafe transportation processes, discharge and use of coal by less dangerous transport refined petroleum gas in place of its direct use; the exclusion of soil disturbance areas, characteristic of open way of coal mining. However serious shortcomings are also inherent in this technology: insufficient controllability of processes for the preparation and the actual heat treatment of seams, low chemical and energy coefficient of efficiency of the process because of the low calorific value gas and relatively high failure rate of gas and coal in the subsoil; relatively low thermal properties of gas of underground coal gasification, significantly inferior to used natural, coke and semi-coke gases, the probability to filter the gas to the surface.

The broader replication of UCG technology can only be discussed in the future, after appropriate research and testing of the most promising developments.<sup>38</sup>

A number of environmental problems encountered by enterprises in their activities did not find effective solutions and require a scientific study. Among them are:<sup>39</sup>

- cleaning technology for mine, quarry and industrial sewage of complex chemical composition from a complex of pollutants (oil products, phenols, mineral salts, sulfates, iron and other heavy metals, trace elements);
- technology and technical means to clean emissions from harmful substances, especially gaseous, resulting from the burning of coal in the boiler;
- ways of managing mine water spouts on the surface of abandoned mines;

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<sup>37</sup> Yu. Proshutin, A. Poturilov, *op. cit.*, p. 43.

<sup>38</sup> *Ibidem*, p. 43–49.

<sup>39</sup> B. Schadov, *op. cit.*, p. 36.

- technology accelerated restoration of the natural potential disturbed by mining and of contaminated land without causing the fertile layer, including the use of bacterial preparations;

- ways of decrease the risk to the environment of overburden and containing rocks and other production wastes classified as I – IV hazard classes;

- elaboration of an innovative financing mechanism of environmental projects;

- organization and procedure of production environmental control at the enterprises of the coal industry;

- monitoring procedure for the thermal state of the waste dumps based on modern methods and technical means.

Solving these problems will create a firm basis for further environmentally sustainable development of the coal industry.

The long-term planning of complex development of the Kuzbass region should take into account the environmental component to restore a healthy environment. For Kuzbass, in which the impact of the coal industry on the environment is excessive, the problem is particularly acute. Planning an effective use of investment opportunities for environmental protection requires the use of economic-mathematical tools to model different environmental measures under the existing legislation and taking into account the priorities of the coal industry and a healthy environment.

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## Abstract

Having survived restructuring period during which the volume of production halved, since 1999 the coal industry has seen a significant growth of its production. However, the positive trends are accompanied by negative impacts for the environment. Further growth of coal has its limits both from economic and ecological points of view.

This paper focuses on the environmental side of the issue, particularly on problems of emissions and wastes producing by coal mining and withdrawal of lands from land use. For Kuzbass as the first in Russia coal mining area, the impact of the coal industry on the environment is excessive, and consequently those problems are particularly acute.

To solve the complex of environmental issues, it is necessary to raise environmental performance to a new qualitative level. That will require more financial, technological legislative and managerial decisions.

**Key words:** coal mining, environment protection, Kuzbass region.