

# Economic and Technological Role of Kuzbass Industry in the Implementation of National Energy Strategy of Russian Federation

**S A Zhironkin<sup>1</sup>, A A Khoreshok<sup>2</sup>, M A Tyulenev<sup>3</sup>, G A Barysheva<sup>4</sup>,  
M C Hellmer<sup>5</sup>**

<sup>1</sup>Dr.Sc. Professor of Economy department, National Research Tomsk Polytechnic University. Russia, 634050, Lenina av., 30

<sup>2</sup>Dr.Sc. Professor of Mining Equipment department, National Research Tomsk Polytechnic University. Russia, 634050, Lenina av., 30

<sup>3</sup>PhD. Assistant professor of Open pit mining department, Kuzbass State Technical University, Russia, 650000, Kemerovo, Vesennya st., 28

<sup>4</sup>Dr.Sc. Chairman of Economy department, National Research Tomsk Polytechnic University. Russia, 634050, Lenina av., 30

<sup>5</sup>MSc in Hydrology and Water Resources Management., Department of Civil and Environmental Engineering, Imperial College London. United Kingdom, South Kensington Campus, London SW7 2AZ, UK

E-mail: <sup>3</sup>tma.geolog@kuzstu.ru

**Abstract.** This article describes the problems and prospects of development of coal mining in Kuzbass - the center of coal production in Siberia and Russia, in the framework of the major initiatives of the National Energy Strategy for the period until 2035. The structural character of the regional coal industry problems, caused by decline in investment activity, high level of fixed assets depreciation, slow development of deep coal processing and technological reduction of coal mining is shown.

## 1. Introduction

Prospects of fuel and energy complex development in Russia, as described in the Energy Strategy for the period until 2035, are based on the main direction of the global energy market transformation – self-providing and import substitution for countries – the largest importers of energy producing materials [1]. Therefore, the strategic initiatives of fuel and energy complex of Russia technological upgrade include the development of energy saving technologies, export diversification and the development of deep processing of coal and oil [2-5]. These initiatives are specified in the key tasks of National Energy Strategy of Russian Federation as the following:

1. Upgrading the power industry means development of oil refining, "smart" power grids, decentralized power generation, upgrading the heating systems.
2. The development of domestic energy infrastructure means eliminating the steady investment imbalance between export, domestic-oriented projects and infrastructure.



Content from this work may be used under the terms of the [Creative Commons Attribution 3.0 licence](#). Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

3. The growth of the domestic energy market means reducing the level of monopolization, establishment of more efficient power market regulation by government and regional authorities, supporting the competition and trade on raw material exchanges.
4. Improving accessibility and quality of energy producing materials, providing modern customer services through the embedding of international technology standards.
5. Increasing the flexibility and diversification of energy producing materials exports.
6. Implementation of the principles of socially and environmentally responsible management of mineral enterprises and holding companies.

## 2. Material and Method

The territories of Russia where energy sources and power producing are concentrated must become the "locomotives" of the National Energy Strategy implementation. Kuzbass (West Siberia, Russia) is one of the famous clusters of Russian heavy industries. Mining industry output of Kuzbass includes coal, iron stone and polymetallic ores (35% of gross regional product in average for 2005-2015). Processing industrial complex of Kuzbass is represented mainly by ferrous and nonferrous metallurgy, primary chemical products and constructing materials (21% of gross regional product).

Significant part of Russian coal production is concentrated in Kuzbass. According to the forecasts, regional coal mining will continue to ramp up the volume of output and it is expected to reach 270 million tons by 2025 [6]. The reason of it is the increasing share of coal in power production in Russia by 2020, at least twice. Today its share is only 12%, while in Western Europe - 40-60%, in USA - 56%, in China - up to 70%. At the same time, Russia has at least one third of proven coal deposits in the world, most of which (more than 690 billion tons) are located in Kuzbass [7]. High quality coal from Kuzbass is consumed in more than 40 countries [8].

In 2012 the total volume of coal mined in Kuzbass was about 200 million tons, including 116 million tons (60.3%) produced in open way. In 2013, it was produced 203 million tons of coal (in 2014 – 211, 2015 - 215 million tons). In addition, there is no reason to believe that in the near future coal consumption will decline. There are 45 coal mines and 56 open pits, 27 coal-processing plants and installations involved in Kuzbass coal industry, 133 thousand people are employed in it [9].

At the same time, technologic and economic development of Kuzbass coal industry is constrained by the problems caused by structural misbalances of regional and national economy.

*The first problem* is the high level of the active part of fixed assets depreciation in coal mines and open cuts (more than 60% averagely) [10]. Therefore, the achievement of strategic targets for coal production requires complete re-engineering of coal enterprises and massive capital investments in the industry. But there are some issues for the capital inflow to Kuzbass industry such as unstable coal prices on the global market, low labor productivity in regional coal industry, a high accident rate, poor investment infrastructure and undercapitalized segment of investment fund market in coal industry. So despite steady growth of coal mining in Kuzbass, total revenue of its sales remains unstable [11]. Operating income of coal companies tends to shortening and investment problems are strengthening consequently.

*The second problem* is insufficient quality of the exported coal from Kuzbass. This is mainly due to the dominance of primarily coal preparation, while whole process of coal preparation up to the most expensive sorts of carbon fuel is developed insufficiently. This suppresses the competitiveness of regional coal industry and its investment potential. So the following "vicious circle" of investment problems of coal industry continues to maintain: "The lack of competitiveness of the coal enterprises - difficulties in fund rising - the preservation of low competitiveness." It leads to shortening the part of unaffiliated investors in coal companies' funds – from 42% in 2010 to 26% in 2014 and then – to keeping Kuzbass economy underinvested [12-13].

*The third problem* is the existence of a significant number of unincorporated enterprises (limited companies) engaged in coal mining in Kuzbass. In 2012, they mined 29 million tons of coal, or 14.3% of total coal production in the region. At the same time they raised their funds by less than 45 million dollars, or 4% of the total investment in Kuzbass coal industry. Along with the unincorporated coal

enterprises, which cannot enter the stock market for capital rising, there is the high proportion of closed corporations, which shares cannot be easily sold to the interested investors. Their part of the total coal output in Kuzbass in 2012 amounted to 15.5%, or 31 million tons. Among them we can name such giants of Russian coal industry as "Raspadskaya Coal Company" with the annual output in 2006 to 10.6 million tons of coal (6.1% of the total volume of Kuzbass), "Holding company "Siberian Business Union" - 9 million tons (53%). Consequently, the limited coal companies and closed corporations summed almost 30% of the total coal output in Kuzbass, and they cannot raise their funds using the stock market in the near future [14].

*The fourth problem* is retarding of new technologies of coal mining and processing implementation, and lag in using of new high-performance equipment. As a result the productivity of Kuzbass coal open pits is in three times less than in the United States (for coal mines is in five times less) [15].

Despite it, coal companies' funds have been used for construction of 25 technological inter-mine rail roads and supporting stations. Special attention is paid to the constructing of coal sea port terminals. Thus coal companies and enterprises of Kuzbass continue to create the processing chain from coal mines and open pits to the ship charter. This allows exporting of 33% of the coal mined in Kuzbass in 2012-2015 [6].

Nevertheless the remaining structural problems of Kuzbass economy lead to the gap between investments and productivity growth. It means that new investments do not sufficiently improve the productivity. The reason of it is using fund rising for out-of-date equipment and restoring the existing machinery by coal companies and enterprises in other industries of Kuzbass economy.

Securing Kuzbass economy specialization on coal mining is supported by dominance of minerals extraction and its primary processing in the regional export. In 2005-2014 up to 90% of the Kuzbass industrial export was represented by three commodity groups [1]:

- fuel and energy products - hard coal, coke and semi-coke. The export of them grew in 2005-2014 from 48.3 to 83 million tons, or more than 3.8 billion dollars per year;

- metals and products from them - semi-finished products, bars, rods, special profiles, flat-rolled products of iron or non-alloy steel, pig iron, aluminum, ferroalloys. During 2005-2014 these articles of Kuzbass export doubled up to 2.9 billion dollars;

- chemical products (mainly heterocyclic compounds and nitrogen fertilizers). Their exports of decreased in 2005-2014 by 26% and amounted to 0.3 billion dollars.

To achieve the goals set by National Energy Strategy of Russian Federation it is necessary to initiate a deep structural transformation of the industry, which cannot be carried out with reasonable-priced raw materials, new productive technologies of processing minerals and investment institutions.

### **3. Results and Discussion**

It is impossible to enhance the role of Kuzbass coal industry in the implementation of National Energy Strategy of Russian Federation without structural changes in the power and mining industries, especially in the segment of production energy producing materials. The following parity: "High technology in processing sector of coal industry - new technologies of fuels production - new ways of fund rising - new investment institutions" is in demand today more than ever. The most important role in the formation of a "bridge" between restructuring of national economy as a whole and its financial sector as a part should be given to the industrial clusters where output of energy producing materials is concentrated.

Such neo-industrialization of Kuzbass economy suggests implies some directions of governing the restructuring of its dominating industries – coal, power, chemistry and metallurgy.

The main direction is providing a transition from the "participation in governing" model of relations between regional business companies and authorities to a model of "participation in innovation". This means a comprehensive encouragement of innovation activity of raw-materials extracting and processing companies and power producers, technology transfer and cross-sectorial reallocation of investment [16-18].

The second (institutional) direction means purposeful change of the most inertial segments of Kuzbass economy structure, mainly formal and informal institutions, mechanisms of reproduction of fixed assets.

The third (resource) direction means a transition from reliance on natural resources as the main source of regional budget revenues to the deep processing of coal, metals, organic compounds based on technological upgrading of machine building, instrument-making, synthetic materials producing plants. It requires, above all, setting the tax and finance incentives to increase productivity of existing processing enterprises along with technological upgrade of coal mines and open pits. The expected results of these measures are reducing of the costs and improving competitiveness of regional industrial companies what was proved many times in different countries [19-23].

The fourth (social) strategic direction is enhancing employment of staff with post-industrial competences. It requires state guarantees in the labor market for training specialists for the companies upgrading their technologies to modern level .

The fifth (integration) direction suggests conglomeration of raw materials and processing enterprises, financial companies, R&D organizations in the high-tech processing holdings. Their competitiveness should be provided by cooperation with national technological platforms and investing breakthrough innovations by commercial banks by long-term project financing [24-26].

Setting goals of structural transformation of Kuzbass economy should be closely linked to implementation of National Energy Strategy of Russian Federation. Therefore, among the main objectives of regional industry complex structural transformation, we emphasize the following.

The primary goals can be reached all together and depend on the solution of main structural problems of the Kuzbass economy:

- modernization of Kuzbass economy industrial sector by deepening of coal processing , increasing productivity of mining, renovation of machine-building plants;
- increase the share of the 5th and 6th technological layers in Gross Regional Product, in tax revenues, in the structure of employment; changes in the sector composition of exports in favor of processing and high-tech enterprises;
- forming competitive on domestic and foreign markets raw-material processing and mechanical engineering clusters;
- developing R&D and innovation activity in basic industries of Kuzbass economy to expand technology transfer from science to industry and business. It requires diffusion of innovations between small, medium and large companies.

Secondary goals, which are also aimed to help implementing structural changes of Kuzbass economy, are achievable only within primary goals:

- developing of market competition in the industry, the financial sector, and infrastructure sectors;
- overcoming the dependence of the state budget revenues of raw materials extracting;
- reduction of the shadow and inefficient non-market segments of regional economy;
- decrease in the proportion of poor people by increasing the role of labor as a factor of producing in high-tech industries.

Determination of the conditions for achieving goals of structural transformation of Kuzbass economy suggests the following.

Firstly, the existence of an institutional framework of structural reforms: regulatory framework, public and private market agents, mechanisms of effective investment redistribution between raw-material and processing sectors of regional economy.

Secondly, the presence of innovation investment infrastructure which helps to promote regional enterprises in domestic and foreign fund markets, small business support, training of the staff of processing enterprises. It should be noted that currently investment infrastructure in Russia are being made by state and occur in the transport and energy systems. Their effectiveness is recognized extremely low by both Russian and foreign analysts [27-29].

Third, the availability of necessary funds and forms of inter-sector capital flow.

Fourth, the formation of the system of scientific and methodological support of Kuzbass economy structural transformation based on ambitioned targets of National Energy Strategy of Russian Federation like development of green power, increasing of energy efficiency in industry, extending alternative power sources.

Fifthly, establishing of state-and-private partnerships in R&D and applied scientific research in coal mining and processing, the power producing.

Considering the fact that Kuzbass coal industry is not only producer of the important energy source, but also the driver of the other sectors' of economy development, it is necessary to preserve and strengthen existing trend of growth in coal production and investment activity. In current structure of Kuzbass economy with raw-material industries domination, it is necessary to create conditions for expansion of brand new segments related to the deep processing of minerals. The leading role in the breading the new segments of Kuzbass economy should play convergent technologies.

We define the development of convergent technologies as an important condition for the implementation of National Energy Strategy of Russian Federation (along with raw-material production technological development and expanding high-tech industries). The content of the convergence of technologies consists of interpenetration and combination of different technological innovations, united by common forms of design, implementing and diffusion [30-31]. Also, technological convergence means the development of industrial clusters like Kuzbass, aggregated development of innovations created in different technological platforms but bringing common product. We have identified the following fist of convergent technologies perspective in Kuzbass:

- technologies uniting biochemistry and power producing (bioenergy), allowing going to the non-waste technologies of environmentally clean fuel producing to replace non-renewable hydrocarbon resources in the foreseeable future [32-33]. Prospects for the development of these technologies we see in the interactions between such technological platform as "Medical and Bio-Technologies", "Energy", "Extraction of natural resources and oil and gas", approved by Russian Government;

- technologies joining producing computer hardware and software (for distributed and "cloud" computing). They will be able to create the integrated telecommunication networks, significantly advancing diagnostic medicine and accelerating development of new machinery by rapidly performing design and multivariate simulation modeling. Their cross-platform character should be achieved with the interaction of such technological platforms as "Information and Communication Technologies", "Electronics and Mechanical Engineering";

- laser informatics technologies that can create a data repository, surpassing existing ones by thousands times. This will speed up the digitization of technological basis and automation of such traditional Kuzbass industries such as coal mining, chemical industry, power producing. Cross-platform interactions can be implemented here in the platforms like "Photonics", "Information and Communication Technologies", "Electronics and Mechanical Engineering."

Productions which can "grow up" from industries dominating in existing structure of Kuzbass economy should become investment "donors" for new processing industries. Therefore, to the promising directions of development of coal mining, deep seated in Kuzbass economy, should be referred the following:

- implementation of non-waste plasma-based technologies of conversion coal organic components to synthetic gas and recovering microelements from it;

- creating of power systems for combined producing of methanol and electricity based on coal gasification and organic synthesis;

- start-up and development of extracting methane from coal seams. Reducing mining safety problems, this gas is used around the world as valuable source of energy. In the USA 40 billion m<sup>3</sup> of methane is produced annually [34];

- development of coal and natural gas processing technologies for manufacturing of high-quality engineering plastics, synthetic materials for electronics and machinery;

- set up of high-tech industry which is rather new for Kuzbass economy – producing of equipment for reducing environmental damage caused by power companies, chemical plants, coal production and foundry.

On the level of the single industry and inter-industries management the coherent and flexible institutional policy of mineral and power sectors technological development is required. Its main elements are the following:

1. The setting up effective national energy market with a high level of competition and market pricing mechanism.
2. Forming a stable tax system for mineral and power sectors, creating balanced systems of custom duties to encourage foreign investment in the deep coal processing.
3. Creating a legal framework that protects the investors' rights and supports the development of competition, removes the excessing administrative barriers.
4. Promote the implementation of advanced coal extracting and processing, energy-saving technologies in Kuzbass mining companies, and encourage the development of technological innovation activity in power sector.
5. Improvement of business relations with traditional European consumers of Russian energy sources producers and establishment of new relations on South Asia market, mainly with China and Thailand partners.
6. Active participation of Kuzbass mining companies in Eurasian power and energy resource market observing general principles of market regulation, providing free distribution of power, energy producing materials, technologies and funds.

#### **4. Conclusion**

Thus, Kuzbass coal industry is to become a driver of structural reforms of Siberian and Russian economy. In accordance with Energy Strategy of Russian Federation, huge technological transformation of coal industry is required, based on transition to deep coal processing, producing new kinds of mineral fuel, improving industrial management and market institutions.

#### **5. Acknowledgement**

The research was made in National Research Tomsk Polytechnic University with financial support of the Ministry of Education and Science of the Russian Federation in the framework of scientific research "The evaluation and improvement of the social, economic and emotional prosperity of senior citizens" contract № 14.Z50.31.0029. Some parts of research were made in Kuzbass State Technical University with financial support of the Ministry of Education and Science of the Russian Federation in the framework of scientific research "Exploring the parameters of technological and technical solutions for selection and development of improving cutting and extracting mining machines operation efficiency in Kuzbass", contract №632. The authors would like to thank to prof. Yury Lesin and prof. Magerram Gasanov for their discussions during the study. We thank anonymous referees for constructive and useful comments on the papers sent via e-mail.

#### **References**

- [1] Zhironkin S A, Tyulenev M A, Zhironkina O V, Hellmer M 2016 The global determinants of mining higher education development *Metallurgical and Mining Industry* **2** pp 62-67
- [2] Zhironkin S A 2001 Factoring and leasing development at coal mining industry of Kuzbass as an important element of its financial part *Ugol'* **4** pp 29-30
- [3] Tyulenev M, Lesin Y, Zhironkin S and Garina E. 2016 Coal producers waste water purification *Metallurgical and Mining Industry* **2** pp 52-56
- [4] Gasanov M A, Gasanova N V, Zhavoronok A V 2016 Information Technologies in Ensuring Continuous Wellbeing of the Person *The European Proceedings of Social & Behavioural Sciences* **VII** pp 323-336
- [5] Zhironkin S A 2002 Prospects and new possibilities investment attracting to Kuzbass coal mining

- industry *Ugol'* **6** pp 31-36
- [6] Tyulenev M, Zhironkin S and Litvin O 2015 The low-cost technology of quarry water purifying using the artificial filters of overburden rock *Pollution Research* **34** (4) pp 825-830
  - [7] Tyulenev M A and Lesin Y V 2014 *Justification complex purification technology open-pit mines wastewater* (Taishan: Academic Forum – Project on Mine Disaster Prevention and Control) pp 441-444.
  - [8] Lesin Y V, Lukyanova S Y and Tyulenev M A 2010 Mass transfer of dispersed particles in water filtration in macro-grained media *Journal of Mining Science* **46** (1) pp 78-81
  - [9] Zhironkin S A 2002 About measures of vexel circulation development and vexelability definition of fuel-and-power complex' enterprises *Ugol'* **4** pp 47-48
  - [10] Khoreshok A 2002 On side cutting bit when operating at sheerer drums *Ugol'* **7** pp 10-11.
  - [11] Zhironkin S A 2001 Governmental factoring development of TEK Kuzbass *Ugol'* **6** p 62
  - [12] Barysheva G A and Novoselova E G 2014 Methodology of Application of the Structural Shift Mechanism for Regulation of the National Economic Management System *Applied Mechanics and Materials* **682** pp 550-554
  - [13] Klemasheva E, Gasanov M and Zeremskaya Y 2016 Neo-Industrialization of Russian Economy as a Source of Social Well-Being Growth *The European Proceedings of Social & Behavioural Sciences* **VII** pp 150-154
  - [14] Lesin Y V, Luk'yanova S Y and Tyulenev M A 2015 Formation of the composition and properties of dumps on the open-pit mines of Kuzbass *IOP Conference Series: Materials Science and Engineering* **91** (1), 012093
  - [15] Wei G L 2011 Statistical analysis of Sino-US coal mining industry accidents *International Journal of Business Administration* **2** (2) pp. 82-86
  - [16] Cushtar C, Matti M and Veron S. 2011 Industrial coal demand in China: a provincial analysis *Resource and Energy Economics* **33**(1) pp12-35
  - [17] Newton A 2011 The impact of ICT and human capital on achieving knowledge-based economy: applications in Malaysia's economy *Int. J. of Green Economics* **5** (3) pp 231 - 247
  - [18] Wang J L, Feng L Y and Tverberg G E 2013 An analysis of China's coal supply and its impact on China's future economic growth *Energy Policy* **57** pp 542-551
  - [19] Danuta Kopycinska and Bruno S Sergi 2008 Economic development and prospects in Poland: an introduction *Int. J. of Economic Policy in Emerging Economies* **1** (2/3) pp 127-136
  - [20] Xinjie L and Hebing L 2015 A brief analysis of the circumstances of the current coal industry and its trends in China *Int. J. Mining and Mineral Engineering* **6**(1) pp 87-96
  - [21] Wang Shicheng 2016 Investment Decision-Making on Renewable Energy Based on Improved Real Option Model *Metallurgical and Mining Industry* **1** pp 36-41
  - [22] Yu Wang and Chengqun Yu 2016 Research on the Database Marketing in the Big Data Environment Based on Ensemble Learning *Metallurgical and Mining Industry* **1** 41-49
  - [23] Letucha O, Samoilenco I and Tkachenko N 2016 State regulation of ecological and economic process as a factor of activation of metallurgical production in Ukraine *Metallurgical and Mining Industry* **2** pp 58-61
  - [24] Gasanov M, Gasanov E, Egorova M The Technologies of the Network Prosperity in Russia *Procedia - Social and Behavioral Sciences* **166** pp 103-106
  - [25] Plotnikova I, Red'ko L and, Yanushevskaya V Social Responsibility of Business *The European Proceedings of Social & Behavioural Sciences* **VII** pp 173-180
  - [26] Engelbrecht-Zenkina Z Analysis of Wellbeing of the Population in the Metropolitan Region Rhein-Neckar (Germany) *The European Proceedings of Social & Behavioural Sciences* **VII** pp 188-192
  - [27] Elsadig Musa Ahmed 2006 The green economy and the knowledge economy: exploring the interface *World Review of Science, Technology and Sustainable Development* **3** (3) pp 270-283
  - [28] Fernandes B, Cunha H and Ferreira P 2011 The use of real options approach in energy sector

- investments *Renewable and Sustainable Energy Reviews* **19** (12) pp 71-80
- [29] Kang P, Cho S and Mac Lachlan D L 2012 Improved response modeling based on clustering, undersampling, and ensemble *Expert Systems with Applications* **39**(8) pp 6738-6753
- [30] Deng Xiaoyi, Jin Chun and Higuchi Yoshiyuki 2011 KSP: A Hybrid Clustering Algorithm for Customer Segmentation in Mobile E-commerce *Journal of Management Science* **24**(4) pp 54-61
- [31] Maclin R and Opitz D. 2011 Popular ensemble methods: An empirical study *Journal Of Artificial Intelligence Research* **11** pp 169-198
- [32] Bose I and Chen X 2009 Quantitative models for direct marketing: A review from systems perspective. *European Journal of Operational Research* **195**(1) pp 1-16
- [33] Antti Haapala and Janne Härkönen 2015 Bioeconomy potential - focus on Northern Finland *Int. J. of Sustainable Economy* **7**(1) pp 66- 90
- [34] BP 2011 *BP Statistical Review of World Energy 2011* (British Petroleum, London)