Kuzbass in the context of strategic challenges: coal chemistry as a solution to economic problems

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Abstract The increase in coal production and export for Kuzbass cannot remain the only factor affecting economic growth in the future. Coal chemical cluster development is one of the ways to diversify regional economy which can not only contribute to monetization of coal resources and attraction of high-tech knowledge-intensive industries to the region but also improve domestic economic efficiency.

1. Introduction
At the end of the second decade of the 21st century, Kuzbass fell into a turbulence zone, i.e. "the fourth energy transition" known as another stage in a series of fundamental structural transformations of the global energy industry [1]. Unlike the three previous energy transitions now "decarbonization and combating global climate change has become the main driver in the fourth energy transition. This is unlike the previous three stages when economic attractiveness of new energy sources prompted changes" [2]. This means further diversification of the global fuel and energy balance biased towards unconventional renewable energy sources and carbon-free or low-carbon technologies. Besides, there is evidence to suggest that the role of coal in the structure of world generation – the main consumer of such type of fuel – will also undergo drastic changes in the years to come.

Decarbonization of the global energy with increasing carbon regulation, together with increasing availability of alternative energy sources, pose increasing risks for coal suppliers. The European Union countries (EU) tend to consistently abandon coal fuel. As such, in the period from 2010 to 2019, 66 GW coal-fired thermal power plants were decommissioned in the EU, despite the fact that the total installed generating capacity in 28 EU countries is constantly growing. Over the past decade, this increase was mainly provided by the construction of wind, solar and hydroelectric power plants [3]. None of the coal power units have been built in the EU since 2016. High competition in the European gas market, leading to a sharp decline in gas prices and oversupply in the gas market, has become an additional factor suppressing coal generation.

In Asian countries, the decline in economic growth and the development of carbon-free generation has led to the fact that the rate of coal TPP commissioning over two decades has decreased four times from 8% (1998-2008) to 2% (2008-2018) [4]. In the summer of 2020, Japan – the prime market for coal from Kuzbass – announced the closure of 100 out of 140 operating coal power plants by 2030; as a result, coal imports to the country will be reduced. Experts estimate that China (the largest coal consumer in the world) will also reduce coal imports by 70-100 million tons over the next 10 years in part because of the slowdown in coal generation growth.

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Decarbonization of the global energy with increasing carbon regulation, together with increasing availability of alternative energy sources, pose increasing risks for coal suppliers. The European Union countries (EU) tend to consistently abandon coal fuel. As such, in the period from 2010 to 2019, 66 GW coal-fired thermal power plants were decommissioned in the EU, despite the fact that the total installed generating capacity in 28 EU countries is constantly growing. Over the past decade, this increase was mainly provided by the construction of wind, solar and hydroelectric power plants [3]. None of the coal power units have been built in the EU since 2016. High competition in the European gas market, leading to a sharp decline in gas prices and oversupply in the gas market, has become an additional factor suppressing coal generation.

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Russia is known to rank third in coal exports, and even the partial implementation of the decarbonization scenario of the global energy can lead to some negative consequences for the national coal industry, create risks for the coal business development which actually depends on exports.

Nonetheless, for both the whole global economy and the fuel and energy complex in particular, 2020 was marked by another severe challenge – a macroeconomic shock – an epidemic spread of COVID-19 viral infection. In general, the IEA predicts a 6% drop in energy demand in 2020. IEA experts believe that the developed countries will witness the largest drop in demand – in the United States by 9% and in the European Union by 11%, with the sharpest decrease in demand for coal (by 8%) and gas (by 5%) [1].

The decline in global demand for coal is a strategic threat to the Russian regions since their economies are based mainly on coal mining. The Kemerovo region – Kuzbass – where almost 60% of all Russian coal is produced heads the risk group (Figure 1).

![Coal production and export in the Russian Federation and Kuzbass, 2018-2019 (mln t)](image)

**Figure 1.** Coal production and export in the Russian Federation and Kuzbass, 2018-2019 (mln t)  
*Source: [5, 6]*

Back in March 2020, some experts were convinced that coronavirus would not affect coal production and the coal companies in Kuzbass would avoid a serious production fall. However, the data for the first half of 2020 indicate the opposite trend. According to the regional department of the coal industry, in January and June 2020, coal production in the region decreased by 11% compared to the same period in 2019 and amounted to 107.7 million tons. The decrease was also noted in the production of coking coal (by 1.6%) and energy coal (by 15.5%) [7].

At the same time, the Kemerovo region suffers serious losses caused by both the global coal market crisis and COVID-19 pandemic. However, before the outbreak of the virus, Kuzbass had been affected by the decline in coal prices for almost a year. In the fourth quarter of 2018, a sharp, deep and, as it became obvious later, protracted drop in coal prices, which primarily affected energy coal, started in Europe. As a result, in January-April 2020, the regional budget revenues amounted to only RUB 43 billion, which is 27% less than in January-April 2019 (RUB 59.2 billion). Kuzbass tax and non-tax revenues decreased by 33% from RUB 52 billion to RUB 35.2 billion. Besides, income tax revenues decreased 2.2 times (by RUB 14.3 billion) from RUB 26 billion to RUB 11.7 billion, which is...
primarily due to a decrease in profits of coal companies. Similar declines were also noticeable in personal income tax (from RUB 12.2 billion to RUB 11.3 billion), mining (from RUB 2.7 billion to RUB 1.6 billion), property (by RUB 550 million), and on a simplified taxation system (by RUB 220 million) [8].

2. Discussion
The current situation requires an urgent revision of state policy regarding coal territories of the country the development models for the resource regions and the creation of effective mechanisms for implementation of their strategic guidelines. The analysis of the Kuzbass experience, unfortunately, shows low efficiency of using strategic planning tools to adapt the economy to the changing environmental conditions. The local authorities and some individual coal companies seem too optimistic about the growth of coal demand in the countries of the Asia-Pacific region [9], which can lead to serious consequences and big problems when choosing a development strategy for Kuzbass and even prolong and deepen the existing recession of the leading Russian coal region.

Strategic development of Kuzbass is rather complex and multilevel. The region has passed several important stages in the development of the national economy:

1. 1930-1950: the eastern wing of the Ural-Kuznetsk plant, the "Kuzbass stoker," mined coal, produced primary metallurgical and coke chemistry products.
2. 1960-1990: monetization of raw materials, creation of a large gas-chemical complex, twenty-fold increase in the value added of final products of the chemical industry, and the development of mechanical engineering.
3. 1990-present: a comeback to the ideology "Kuzbass is the main stoker" now not only of the country but the whole world, and the loss of more than half of value added chains.

Such a development model makes the Kuzbass economy extremely vulnerable. The economic growth of Kuzbass has always been based on both direct and indirect state support, with its forms and instruments changing at various stages of regional development, but the government aid has always been provided and played a decisive role. Such measures manifested state pragmatism (and to some extent patriotism) rather than state altruism, taking into account the interests of the country. However, over the past twenty years, the state policy towards the Kemerovo region has been indistinct and unclear.

The recently completed Support Program for the coal industry in Kuzbass as part of restructuring the Russian coal industry is the only example of a full-scale state project for the development of the region during the whole period.

At the same time, investing a lot of money, the state and, to a greater extent, regional authority "forgot" to set the main "rules of the game" for businesses: all in the name of a person, all for the good of men. As a result, over the past twenty-five years, the coal output in the region increased 2.5 times, but the standard of living (real monetary income of the population) during the same period increased by only 22%, and over the past ten years this indicator has continuously decreased (Figure 2). The number of people employed in the Kuzbass economy in 2007-2018 has also decreased by more than 130 thousand people, or 10% (staff cuts were observed mainly in metallurgical and engineering production, agriculture, forestry, and trade). However, the structure of the national economy has remained almost the same with the dominant of coal industry (about 40% in the structure of GRP).
Figure 2. Dynamics of individual indicators of economic development of the Kemerovo region in 2007-2018 (2007 = 100%; "coal production" - million tons)

Source: calculated by the authors based on Kemerovostat data

Today it has become obvious that Kuzbass cannot rely only on an increase in coal output and its export as a factor of economic growth.

Thus, it is essential for Kuzbass to develop a system of effective measures and solutions, not losing sight of the prevailing political and economic realities, that would ensure the regional security and smooth transformation in the conditions of "the fourth energy transition" and the ongoing COVID-19 pandemic.

All the Development Strategies (Figure 3) are based on diversification of regional economy, primarily by both improving the existing capacities and development institutions (e.g. engineering and tourism clusters, advanced production zones, oil refining cluster, etc.) and by creating new industries
Great expectations are placed on the development of the coal chemical cluster. Let’s recall the famous ten theses in favor of Kuzbass coal chemistry development:

1. There is no any other option.
2. This is the world practice for economic development.
3. The coal chemical cluster has already been formed in Kuzbass.
4. Coal chemistry is rather profitable.
5. Kuzbass conducts unique applied research.
6-7. Specific investment projects are being implemented in Kuzbass (RUB 120 billion of products and 16,000 jobs), thereby the region creates a full-fledged industry.
8. Kuzbass trains personnel for the new industry.
9. Kuzbass develops engineering infrastructure.
10. The coal chemical cluster will have a synergistic effect on a number of industries.

In 2014, the Russian government adopted a set of measures to develop the coal chemical industry and increase the production of coal chemical products, which will create a stimulating environment for the development and introduction of deep coal processing technologies [10]. In 2015, the Federal Research Center for Coal and Coal Chemistry of the Siberian Branch of the Russian Academy of Sciences was created in Kemerovo. The Coal Industry Development Program of the RF for the period until 2035 calls the investors to:

![Building blocks model of economic development of Kuzbass](image_url)
• create coal technological clusters in Kuzbass, including the complexes for the production of semi-coke;
  • build power plants operating on coal bed methane and combustible gas from the production of semi-coke;
  • develop the production of thermocoke, smokeless fuel, coal briquettes and similar products, improving the properties of low-calorie coal;
  • encourage the development of deep coal processing (semi-coking, gasification, synthetic liquid fuel, etc.).

The global response to the development of coal chemistry is rather complicated. Both supporters and opponents understand that coal chemistry:
  • can potentially become a serious player in the markets of fuel and large-capacity chemical products;
  • large-tonnage production from coal is several times more capital-intensive than the similar production from oil and natural gas;
  • over the last half century, there have been no breakthroughs in deep coal processing technology;
  • large-capacity coal chemistry could be developed only in the countries without sufficient oil and gas deposits and which do not occupy the leading positions in the global climate agenda.

China is an example of such an approach. Today, this country is the leading center for the development of global coal chemistry. Chinese government considers this industry as an important factor that ensures energy security and sustainable development of the country and encourages the development of coal chemical science and production in all areas: extraction of organic components of coal by chemical methods; direct coal liquefaction into liquid fuels; gasification for syngas production; production of motor synthetic fuels; production of methanol, glycols and dimethyl ether; conversion of methanol to gasoline; production of olefins and polymers, etc. [11]. Today, in China the number of industrial coal gasification projects is in the hundreds, and the production of liquid fuels from coal is being undertaken. China provides 100% of the global production of coal methanol and coal olefins. Chinese coal industry accounts for 80% of the country's total production capacity for ammonia and polyvinyl chloride [12].

3. Conclusion
In view of the above, it seems reasonable to take a fresh look on the motives of the Kemerovo region and the development goals of its coal chemical cluster. By and large, there are three main goals for regional economic development:
  a) monetization of coal resources, substitution of coal in export markets for products with high value added;
  b) attraction of high-tech knowledge-intensive industries to the region;
  c) increase in internal efficiency of the national economy due to the use of scientific, technological and food potential of coal chemistry.

As far as the main goal is concerned – monetization of coal resources and substitution of coal in export market – unfortunately, in view of the prevailing and estimated trends in oil and gas prices, the large-capacity coal production under the current conditions in Kuzbass is rather uncompetitive for private investments. Fundamentally new solutions are needed in the development of coal-to-liquids and gas-to-liquids technologies and the synthesis of large-scale polymers, which makes their efficiency higher than the similar oil production (US $30 per barrel). The Institute for Coal Chemistry of the SB RAS is expected to take charge of the research on the development of such technologies.

Before such research is conducted, the oil processing industry in Kuzbass, given the adequate investment policy, can replace the foregone revenue from coal exports: in the Kemerovo region there are 9 oil refineries, the volume of oil products processing in the region amounted to 4.7 million tons in 2018. The capacity of the largest plant – the Yaisk Oil Refinery – is about 6 million tons (including the second production line); oil refinery depth can reach 93%. The product range of Kuzbass oil refineries is quite wide from the traditional ones – fuel oil, diesel fuel, etc. – to the projected ones –
Euro-5 gasoline (the launch is scheduled for 2020). In the medium term, it is advisable for the Yaysk Oil Refinery to develop the synthesis of large-scale chemical products such as olyethylene and polypropylene crumbs.

The second and third objectives can also be achieved, provided that the synthesis of high molecular polymers is developed in the region. But first, it is necessary to create a production zone for modern knowledge-intensive low-tonnage chemistry in the close proximity to the oil refinery. With an increase in coal production, the solution of environmental problems in Kuzbass is associated with an increase in underground production and a relative reduction of open production. This approach will automatically lead to the need for installing in-seam drainage systems and, as a result, the development of methane coal industry.

The challenges the Kuzbass coal chemical cluster has faced show that not a single Siberian region will be able to implement large investment projects on its own, as it requires fundamentally new knowledge about the issue, which can be obtained only if the potential of other regions is used. It is necessary for the Kemerovo region to maximize and seize the opportunities offered by regional integration in the field of innovation, science, and education. It is through the development of deep coal processing cluster that Kuzbass can exert an active influence on the development strategy of Siberia.

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