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**КӨМҮРСҮЗ ЭНЕРГЕТИКА: БОРБОРДУК АЗИЯ ҮЧҮН ЖАШЫЛ ЧАКЫРЫКТАР  
ЖАНА МҮМКҮНЧҮЛҮКТӨР (КЫРГЫЗСТАН ЖАНА КАЗАХСТАН)**

**ЭНЕРГЕТИКА БЕЗ УГЛЯ: ЗЕЛЕННЫЕ ВЫЗОВЫ И ВОЗМОЖНОСТИ ДЛЯ  
ЦЕНТРАЛЬНОЙ АЗИИ (КЫРГЫЗСТАН И КАЗАХСТАН)**

**ENERGY WITHOUT COAL: GREEN CHALLENGES AND OPPORTUNITIES  
FOR CENTRAL ASIA (KYRGYZSTAN AND KAZAKHSTAN)**

**Кыскача мүнөздөмө:** Макалада көмүрдүн колдонулушуна жана анын экологияга тийгизген таасирине басым жасоо менен Казакстан менен Кыргызстандагы энергетикалык абалды талдоо жүргүзүлөт. Эки мамлекет тең глобалдык климаттык демилгелерге ылайык көмүрдү керектөөнү кыскартууга жана кайра жаралуучу ресурстарга өтүүгө артыкчылык беришет. Макалада жылуулук берүү мезгилинде көмүрдү пайдалануу энергетикалык структурада негизги ролду ойногон Борбордук Азияда туруктуу өнүгүүнү камсыз кылуу үчүн бул кадамдын мааниси баса белгиленет.

**Аннотация:** В статье проводится анализ энергетической ситуации в Кыргызстане и Казахстане, с акцентом на использовании угля и его воздействии на экологию. Оба государства придают приоритет сокращению потребления угля и переходу к возобновляемым ресурсам в соответствии с глобальными климатическими инициативами. Статья подчеркивает важность этого шага для обеспечения устойчивого развития в Центральной Азии, где использование угля в отопительном сезоне играет ключевую роль в энергетической структуре.

**Abstract:** The article analyzes the energy situation in Kazakhstan and Kyrgyzstan, with an emphasis on the use of coal and its environmental impact. Both countries prioritize reducing coal consumption and transitioning to renewable resources in line with global climate initiatives. The article highlights the importance of this step for ensuring sustainable development in Central Asia, where the use of coal in the heating season plays a key role in the energy structure.

**Негизги сөздөр:** жашыл экономика; көмүр энэр жайы; энергетика; кайра жаралуучу ресурстар; геологиялык запастар; газ.

**Ключевые слова:** зеленая экономика; угольная промышленность; энергетика; возобновляемые ресурсы; геологические запасы; газ.

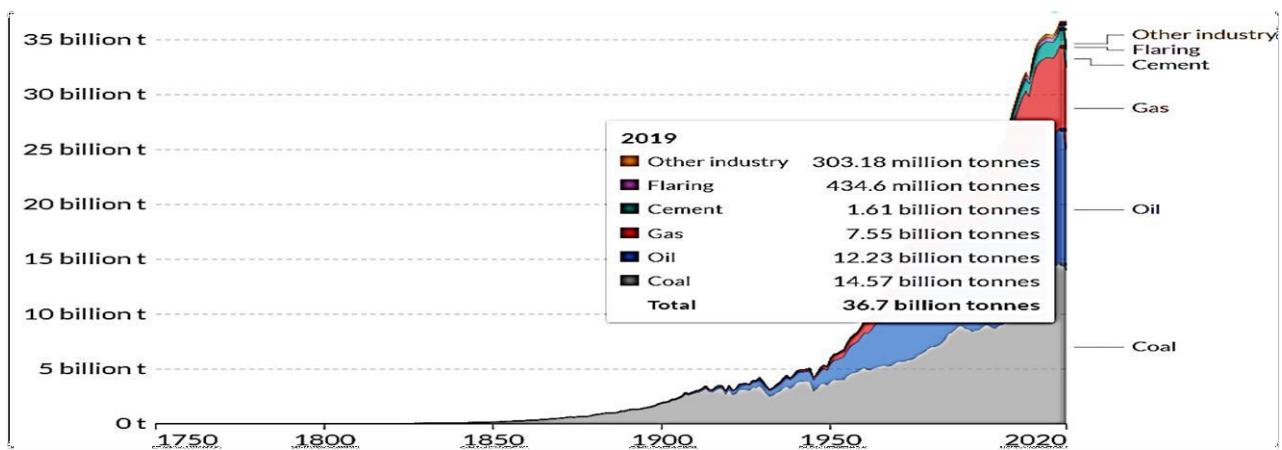
**Keywords:** green economy; coal industry; energy; renewable resources; geological reserves; gas.

Climate change is a global problem nowadays. Many factors affect this phenomenon. One of the main factors is Greenhouse Gas Emissions. Emissions of carbon dioxide into the atmosphere are a consequence of human activity. There are different kinds of emissions, but the emissions that we will consider in this paper will be associated with the use of coal. Heating is the main energy resource used by many countries around the world. Even though some of them are provided with both electricity and gas, many prefer coal and wood, which applies to the countries of Central Asia. Recently, the increase in atmospheric emissions is a consequence of the development of the world economy and its need for energy. This also applies to climate change on the planet, wherein in some parts there is an increased demand for energy for heating and cooling. Based on the data from Our World in Data, the coal industry ranks first among other fuel industries in terms of carbon dioxide emissions [1]. —The burning of coal is responsible for 46% of carbon dioxide emissions worldwide and accounts for 72% of total greenhouse gas (GHG) emissions from the electricity sector. [2].

Cutting emissions from coal production is a main global priority. In addition to these pressing concerns, it is crucial to highlight that coal mining and transportation contribute to environmental degradation and pose health risks to local communities. This emphasizes the need for a comprehensive approach that considers not only the reduction of emissions but also the broader environmental and social impacts associated with coal usage. This paper will discuss the evidence from two countries of Central Asia: Kazakhstan and Kyrgyzstan, the importance of the coal industry in the energy sector of these countries, as well as a transition away from it.

In Kazakhstan, the coal industry is one of the largest sectors of the economy, which is the basis of the energy complex along with the oil and gas industry. In the current structure of fuel generation, coal accounts for the main share – 74% of the total equivalent fuel consumption. Annually 100-120 million tons of coal are mined in the country. The extraction and utilization of coal play a pivotal role not only in energy production but also in shaping Kazakhstan's economic landscape, providing employment opportunities and contributing significantly to the national GDP.

Coal is widely used in the heavy and mining industries, as well as in other industries related to the extraction of minerals. Approximately 40% of the total volume of consumption is the share of metallurgy and other industries in the overall structure of coal consumption, comparable to the figure for the domestic sector [1]. These consumption patterns underscore the multifaceted role of coal in sustaining various sectors of the Kazakh economy, presenting both challenges and opportunities for a sustainable transition [3]. The total geological reserves of coal in Kazakhstan exceed 283 billion tons. Of the total balance reserves, hard coals account for 22.3 billion tons, or 63.3%, including coking coals - 5.4 billion tons [4]. Understanding the vast geological reserves of coal in Kazakhstan provides insights into the long-term considerations and potential impacts associated with transitioning away from coal-dependent energy sources. Kazakhstan's main goal is to achieve carbon neutrality by 2050 by expanding the use of renewables to 83%. This ambitious target reflects the country's commitment to mitigating climate change and underscores the importance of a comprehensive shift toward renewable energy sources in achieving sustainable development goals.



Annual carbon dioxide (CO<sub>2</sub>) emissions from different fuel types, measured in tons per year

The share of production and consumption of coal in Kyrgyzstan is much less in comparison with Kazakhstan, since the level of industrialization in the country, as well as reserves, must be taken into account. Kyrgyzstan has limited oil and gas resources, and coal is the main fuel. The coal industry is an integral part of the industry of Kyrgyzstan. In the fuel and energy balance of the republic, the share of coal is more than half. According to the estimates of the Ministry of Energy and Industry, the country's annual demand for coal today is more than 3 million tons. Over the past ten years, the need has increased 4 times [5].

Kyrgyzstan consumes a significant amount of coal. In 2021 3.062 thousand tons of coal were extracted, and in 2022, this figure increased to 3.636 thousand tons. One of the primary coal mining areas is the Kavak coal basin, particularly the Kara-Keche brown coal deposit, where nearly half of all coal in Kyrgyzstan is extracted (1.708 thousand tons in 2022) [6]. The majority of the extracted coal is used in the energy sector, communal services, and for the production of construction materials. The trend of coal consumption and extraction continues to increase from year to year.

Coal extraction in Kyrgyzstan, such as at the Kara-Keche deposit, is carried out through opencast mining, with more than half of the coal immediately turning into fines and dust after extraction [7]. Environmental issues arising from the direct or indirect impact of coal dust during

mining include water pollution (both surface and underground), air pollution, land disturbance, and landscape changes. The location of the deposit in high-altitude terrain, in close proximity to glaciers, directly leads to their pollution and physical destruction.

In turn, this leads to the destruction and degradation of vegetation, glacier melting, the emergence of threats to the genetic diversity of plants, animals, and humans, increased illness among coal mining workers and residents of nearby settlements, and some other consequences. Coal transportation in Kyrgyzstan primarily occurs through two modes of transport – railway and road. It is noteworthy that there is no distinction in terms of coal transportation method, as the main pollution occurs due to the generation and dispersion of dust from the coal surface.

At coal loading/unloading points, the air dustiness at a distance of 5 meters from the loading/unloading node can range from 50 to 100 mg/m<sup>3</sup>, while directly in the loading/unloading zone, it can reach 93 g/m<sup>3</sup>. It is noteworthy that the permissible concentrations of dust in such areas, i.e., those that do not harm human health and the environment, depend on the silica content in coal dust and range from 1 to 10 mg/m<sup>3</sup> [8]. During coal transportation, the process of dust dispersion from the coal surface plays a significant role in atmospheric pollution. For instance, at wind speeds exceeding 3-4 m/s, 3-5% of the coal mass is lost as blown dust for every 300 km of travel. Additionally, the interaction of vehicle wheels with the road surface raises a considerable amount of dust and other pollutants. Furthermore, exhaust gases contribute to air pollution as the coal is in motion. The air dustiness in the roadside area can range from 10 to 100 mg/m<sup>3</sup> [8].

The main period of emissions in Kyrgyzstan is the heating season. For several years in a row, Bishkek has taken the top place as a city with polluted air. During the heating season, most households prefer to use coal due to its price and availability. As for gas and electricity, there are problems with this. A small number of regions of the country are equipped with gas, so there are problems with accessibility. As for electricity, its power decreases sharply during the heating season, and this is not enough to heat private houses. Therefore, that is why the main goal for Kyrgyzstan is the transition from coal to renewable sources, and to achieve carbon neutrality by 2040. It is worth noting that Kyrgyzstan faces particular challenges with air quality, especially during the heating season, as evidenced by Bishkek's recurrent position as a city with polluted air. Additionally, the transition from coal to renewable sources aligns with Kyrgyzstan's commitment to achieving carbon neutrality by 2040, signaling a proactive stance in addressing environmental concerns and sustainable energy practices.

At the 40th World economic forum in 2010, held in Davos under the theme "Improve the state of the planet: rethink, redesign, rebuild the world," a model was chosen that declared a new global course towards a green economy as the only path for further development. Currently, the concept of "green economy" is at the forefront in the business environment, becoming a global course for innovative, crisis-resistant development in many countries and regions worldwide. "Environmentally friendly" energy and low-carbon emission technologies replace fossil fuels in the "green" economy, reducing climate impact while simultaneously creating high-quality jobs and decreasing dependence on imports. The implementation of innovative technologies aimed at enhancing energy and resource efficiency opens new prospects for development in various sectors, compensating for job losses in traditional industries of the "brown" economy. Despite some negative environmental manifestations in Kyrgyzstan compared to neighboring countries, the country has quite favorable starting opportunities for the development of a green economy. Kyrgyzstan lacks large chemical, petrochemical, and metallurgical productions that significantly harm the environment. Another positive factor is that the republic's primary electricity-generating

capacities are based on hydroenergy resources, and the use of electricity generation based on harmful hydrocarbons is limited to one thermal power plant. Kyrgyzstan does not have major productions of mineral and chemical fertilizers, resulting in agriculture not extensively using them. Overall, according to the World Bank data, the environmental situation in the republic is more favorable compared to other countries in Central Asia. This allows for hopeful expectations regarding the successful implementation of green economy principles in the country and the creation of a national brand, "Kyrgyzstan – a country of green economy." Due to the utilization of renewable hydro resources in Kyrgyzstan, more than 90% of electrical energy is generated by large hydroelectric power stations. However, the potential of micro and small hydroelectric power stations is practically untapped. Unlike large hydroelectric power stations, mini hydroelectric power stations have minimal impact on the environment and do not harm the local ecosystem. The development of the small hydropower sector also contributes to strengthening the country's energy security, especially during periods of low water levels, providing electricity to remote regions and reducing dependence on the sole large source of electricity generation - the Toktogul hydroelectric power station.

Kyrgyzstan and Kazakhstan have set clear goals for themselves, for which a considerable number of projects have already been devised to achieve them. Any project requires high costs, as well as the involvement of the population. The climatic conditions of Kazakhstan and Kyrgyzstan are quite different. If the territory of Kyrgyzstan is dominated by mountainous terrain, then the territory of Kazakhstan is steppes. Kyrgyzstan, unlike Kazakhstan, does not have rich oil and gas resources, but there is an advantage in water resources. Among the large number of proposed ideas and projects to achieve the goal of the two countries, we decided to select only the most basic ones. Our choice is due to the climatic conditions of the two countries, as well as the effectiveness of their implementation. As previously mentioned, Kyrgyzstan has rich water resources, which are currently only 10% used. In this regard, the main and correct solution for Kyrgyzstan will be the installation of hydroelectric power plants, which are already in the process of development and installation. Additionally, considering Kyrgyzstan's mountainous terrain and abundant water resources, there is a significant potential for the implementation of hydroelectric power plants, aligning with the country's natural advantages. As for Kazakhstan, also relying on their climatic conditions, the right decision for them would be to focus on solar and wind power plants. Given Kazakhstan's vast steppes and climatic conditions, prioritizing solar and wind power plants is a strategic decision, leveraging the country's renewable energy potential and contributing to sustainable development.

In response to the challenges posed by the environmental impact of coal usage, both countries are actively exploring alternatives and considering the long-term consequences. Given the above, we can conclude that the coal industry plays an important role in the energy plan of the countries. The main use falls on the heating season, which is associated with a large Greenhouse Gas Emission into the atmosphere during this period. However, two countries are considering the seriousness of its use, as well as the consequences in the long term. Therefore, this issue is now acute all over the world, and the term "global warming" is becoming mainstream. Fortunately, countries have chosen the right direction to reduce this problem. Of course, a complete exclusion of the use of coal is not expected, but its maximum limit is in the future. The task is to find ways to reduce the share of coal in the country's energy balance. The health of the population, tourism income, and the production of environmentally friendly goods are important factors for the country's development. Reducing coal consumption contributes to a decrease in environmental pollution and increases the attractiveness of the country. In the future, Kyrgyzstan's key export

commodity will be its nature. However, due to the lack of accessible alternative energy sources, a complete abandonment of coal is currently impossible. Kyrgyzstan plans to implement a phased series of projects for the construction of hydroelectric power stations on its territory, which are environmentally friendly sources of energy. Inviting investors for mutually beneficial cooperation in the hydro-energy complex, including the principles of public-private partnerships, may partially solve this problem. It is also important not to forget about other alternative energy sources. For example, ecologists suggest using energy from waste, where the volume of generated electricity in landfill sites, according to their calculations, could reach 360 megawatts. This is equivalent to the electrical power of the local thermal power stations. It is promising to note that both countries are actively addressing the environmental implications of coal usage and are aligning with global efforts to combat climate change. The commitment to reducing coal consumption is a significant step towards mitigating the impacts of global warming.

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