Increasing technological sovereignty in dump trucks production facing economic sanctions

D.M. Dubinkin[1] and *N.N.* Golofastova[1*]

[1]T.F. Gorbachev Kuzbass State Technical University, 650000, Kemerovo, 28 Vesennyaya Street, Kemerovo, 650000, Russia

Abstract. The article reflects the results of R&D on the design of a Jupiter mining truck with a lifting capacity of 240 tons. Increasing the unit load capacity is a fundamental factor of economic efficiency, as it ensures a reduction in costs, despite the high cost. This is precisely the path taken by foreign companies engaged in open-pit mining. At the same time, the pressure of sanctions from unfriendly countries limits the import of quarry equipment in all its segments. An analysis of the state of the Russian market for mining dump trucks and the state of the domestic automotive industry for the production of heavy mining dump trucks is provided.
Keywords: Open-pit mining, heavy dump trucks, import substitution.

1 Introduction

The coal industry has been and remains one of the most important in Russia; it provides not only heat and electricity generation, but is especially necessary in metallurgy, where coking coal has yet to be replaced. No type of "green" (renewable) energy sources can fully replace fossil hydrocarbons.

Despite the sanctions pressure of unfriendly countries, coal mining continues to develop, developing the Asia-Pacific region. Russia's isolation from the export of fuel and energy resources to Western markets creates certain, but surmountable, difficulties, at the same time opening new windows of possibility to strengthen the energy sovereignty of our country [1-10].

One of the directions is import substitution in the field of application of heavy-duty dump trucks in open-pit mining operations. The market of dump trucks in Russia has undergone significant changes in recent years due to the ban on the export of foreign dump trucks to Russia. Imports of foreign mining equipment in 2022 decreased by a third year-on-year. This niche was filled by Belarus and China, while the share of their exports to Russia increased many times [1].

2 Materials and Methods

In 2021, there was a noticeable increase in the renewal of dumping equipment due to the recovery of the Russian economy after the "covid" period. In January - April 2023, dump

* Corresponding author: oegnn@mail.ru

trucks with wheel arrangement 8x4 and 6x4 were in demand in the market of truck equipment, which in general showed a growth of more than 20%. At the same time, about 80% are dump trucks of Chinese manufacturing [1].

Table 1. The most popular dump truck brands in the Russian market (of total sales volume)) [1].

Shacman / Shaanxi	27.4 %
FAW	21.6 %
KAMAZ	15.7 %
Howo	14 %
SITRAK	10.1 %
Other	11.5 %

Table 1 shows the brands with different payload capacities. At the same time, the global trend is to increase the unit payload capacity of dump trucks, as their use in the conditions of open-pit mining operations has significant economic advantages

3 Results and Discussion

Today the state of the Russian automobile industry in the production of dump trucks is as follows (Table 2).

Table 2. SWOT-analysis results of the state of the Russian automobile industry in the production of dump trucks.

Advantages	Possibilities
Growing demand on the Russian market for heavy-duty dump trucks. Availability of Russian research and production structures (for instance, PJSC KAMAZ). Significant experience of Russian companies in the production of dump trucks of various capacities. Government support of modern developments in the field of high-tech production of dump trucks.	Reduced competition due to the withdrawal of foreign manufacturers' dump trucks from the market Import substitution program. Expansion of the sales market of dump trucks in friendly countries. Increase of jobs in the Russian economy. Possibility of participation in cooperation between technical universities of Russia and industrial partners. Increase of economic efficiency of transportation processes. Reduction of danger of transportation processes. Elimination of risks and errors in the transportation process due to the elimination of the human factor.
Shortcomings	**Threats**
Insufficient connection between the production of dump trucks and scientific and technical structures. Owners' insensitivity to the proposals of science in the field of digital transformation of mining processes. Orientation of owners to foreign markets of dump trucks.	Inability to provide the repair base with spare parts and large-size tires for foreign-made dump trucks in operation. Increased cost of production and operation of dump trucks due to price growth. Insufficiency of components of systems of autonomous movement of dump trucks in the quarry domestic production. Restriction of import of components for the production of dump trucks. The need to employ released drivers when implementing digital transformation in transportation of rock mass in the quarry.

In this connection the main directions of state support measures, allowing to improve the situation with coal sales, have been formed (tab. 3).

Table 3. Government support measures for the coal industry, according to market participants [8].

By the Ministry of Transport of Russia	- leasing a sufficient volume of bulk carrier fleet for coal transportation, including with the participation of private Russian companies within the framework of public-private partnership; - development of coal transportation along the Amur and Ussuri rivers, focused on export to China; - development of coal transportation along the Northern Sea Route, focused on remote areas of the North and Far East of Russia, as well as on exports to the Asian region.
By the Russian Ministry of Transportation and Russian Railways:	- expansion of the capacity of Russian Railways railroads in Khabarovsk Krai to increase shipments to Vanino ports; accelerated commissioning of the Eastern polygon facilities and development of its infrastructure to the extent consistent with the objectives for Kuzbass and the Far Eastern Federal District, without infringing on the development plans of other coal-mining regions of the Russian Federation; - expanding the capacity of border crossings with the PRC; - increasing the priority of coal in transportation by Russian Railways.
By the Ministry of Foreign Affairs of Russia and the Ministry of Energy of Russia:	- preventing Turkey and other friendly and neutral coal consuming countries from joining the embargo on Russian coal supplies imposed by the EU; - probing the situation with friendly and neutral coal-consuming countries with a view to signing intergovernmental agreements on Russian coal supplies. probe the situation with friendly and neutral coal consuming countries to sign intergovernmental agreements on the supply of Russian coal products with the definition of specific volumes and delivery terms.
By the Ministry of Finance of Russia, the Ministry of Energy of Russia and the Ministry of Economic Development of Russia:	- removal of restrictions on the inclusion of coal companies in the program of subsidizing interest rates on loans; - removal of all restrictions and creation of incentives for parallel import of machinery, equipment and components necessary for the development of the coal industry.
By the Ministry of Industry and Trade of Russia:	- providing assistance to industrial enterprises engaged in the creation of production facilities for import substitution of equipment for the Russian coal industry.

Thus, when resolving issues with coal supply logistics, the main issue becomes import substitution in the production of heavy-duty dump trucks, components and spare parts. As mentioned above, 2021 showed a significant renewal of mining equipment in all its segments. By 2023, serious reorientation of coal exports to APR and BRICS countries has been achieved (Table 4).

Table 4. Russian coal exports in 2023 [3].

Coal export destinations	Export growth, %
China	52
India	43
BRICS countries	46

Coal supplies to friendly countries have grown by 68% in two years, accounting for 82% of the total volume. On the instructions of the President of the Russian Federation, a program for the development of the coal industry was approved, the purpose of which was to increase exports to the East [2].

Earlier we noted that in 2021 in Russia there was a significant renewal of the fleet of dump trucks. However, there was a problem with components and spare parts for imported dump trucks purchased earlier. The demand for them has increased and cannot be satisfied again due to Western sanctions (Table 5).

Table 5. Increase in demand for spare parts to repair imported dump trucks in 2022, % [2].

Brake pads	63.7
Hydraulic cylinders	25.6
Gearboxes	29.0
Starters	15.5
Hubs	20.6

The leading mining regions in the Russian Federation are the Far East and Kuzbass. Kuzbass provides production of more than 200 million tons per year, which is half of all minerals produced in 2023, and it is mainly coking coal. For import substitution of large-capacity dump trucks, the Federal State Budgetary Educational Institution of Higher Professional Education "Gorbachev Kuzbass State Technical University named after T.F. Gorbachev" (Kemerovo) under an agreement with the Ministry of Science and Higher Education of the Russian Federation is implementing a complex project "Creation of high-tech production of autonomous dump trucks with a payload capacity of 240 tons with domestic traction drive for operation in the system of digital mining of minerals by open-pit mining". The Terms of Reference define the systems and units to be developed, as well as the components to be mass produced.

The degree of novelty of the designed systems and units is presented in Table 6.

Table 6. Systems and units of the projected dump truck "Jupiter" with payload capacity of 240 tons.

Newly developed	Newly developed (based on purchased items)	Series production
1. Engine heat maintenance system - to ensure optimal engine heat when driving in sub-zero temperatures	1. Electromechanical transmission	1. Engine
2. Air supply system - air filter - dry, with clogging indicator. Air intake with multicyclones	2. Support system: frame system	2. Tire size 40R57
3. Suspension: front - hydropneumatic; rear - dependent hydropneumatic suspension	3. Steering drive: electrohydraulic type	
4. Dump platform	4. Braking system: hydraulic type	
	5. Low-voltage electrical equipment	
	6. Fire extinguishing system	
	7. Automatic central lubrication system	

4 Conclusions

As follows from the data in Table 6, the dump truck layout should contain 13 systems and units. Of them 2 units or 15.4% are purchased (serially manufactured), 7 approaches or 54.1% are newly developed with application of part of purchased approaches and 4 units or 30.6% are completely new.

Thus, the novelty coefficient of the Jupiter 240 project development will amount to 0.7. It is stipulated that 30% of purchased items in the designed systems and units will be of Russian production. Therefore, the project meets the requirements of the import substitution plan.

Acknowledgements

The work is financially supported by the Ministry of Science and Higher Education of the Russian Federation under the agreement dated 07.04.2022 № 075-11-2022-016 with PJSC KAMAZ on the integrated project "Development of high-tech production of autonomous mining dump trucks with a lifting capacity of 240 tons with a domestic traction drive for operation in an open-source digital mining system", with participation of T.F. Gorbachev Kuzbass State Technical University in terms of research, development and technological works.

References

1. Sales of new trucks in Russia in 2023 and in December. Sales of new trucks in Russia in 2023 and in December. - URL: https://www.autostat.ru/press-releases/56570/. (date of reference 16.02 2024).
2. Russian market of dump trucks-2022-2023. - URL: https://spec-technika.ru/2023/06/rossijskij-rynok-samosvalov-2022-2023/. (date of reference 09.03.2024) - Text electronic.
3. Fuel and Energy Complex of Russia today and tomorrow: results and objectives. URL: https://energypolicy.ru/tek-rossii-segodnya-i-zavtra-itogi-i-zadachi/business/2024/12/25/ (date of reference 09.04.2024).
4. Dubinkin D. M. M. Bokarev A. L. "Mining Equipment and Electromechanics" **5**, 31-44 (2023). DOI: 10.26730/1816-4528-2023-5-31-44.
5. O.S. Maximova *The current state of the market of quarry dump trucks and its impact on open pit mining.* Innovations in information technologies, mechanical engineering and motor transport. Collection of materials of VI International Scientific and Practical Conference November 30 - December 01, 2022, Kemerovo, pp. 649-654.
6. D. M. Dubinkin, N. N. Golofastova Competitiveness in the global world: economics, science, technology **5.** 180-184 (2022)
7. Dubinkin D.M., Pashkov D.A/Coal **4**, 42-48 (2023)
8. Report on the progress of implementation in 2021 of the measures of the Program of development of the Russian coal industry for the period up to 2035 from 01.06.2022 № CM-7541/122.- URL: https://energo.eco/projects/doklady/doklad-o-khode-realizatsii-v-2021-godu-meropriyatiy-programmy-razvitiya-ugolnoy-promyshlennosti-ross/.(date of reference 02.02.2023).
9. D. M. Dubinkin, N. N. Golofastova // Competitiveness in the global world: economics, science, technology. - 2022. **5.** 180-184.
10. N. N. Golofastova, D. M. Dubinkin, E. A. Grigorieva // Issues of regional economy. - 2021. **3(48).** 25-30