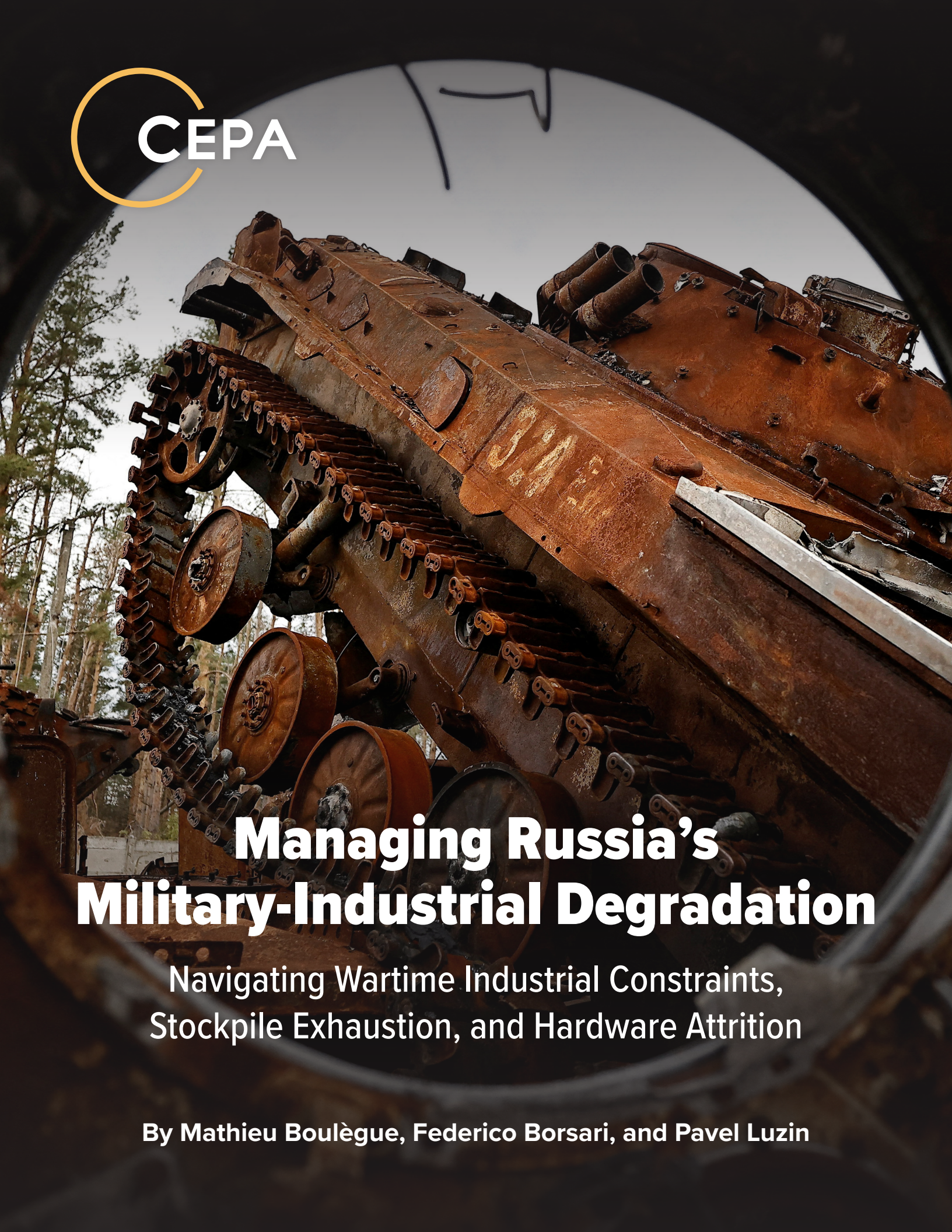


Managing Russia's Military-Industrial Degradation

Navigating Wartime Industrial Constraints, Stockpile Exhaustion, and Hardware Attrition

By Mathieu Boulègue, Federico Borsari, and Pavel Luzin

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Cover photo: A view shows destroyed Russian tanks and armoured vehicles, amid Russia's invasion of Ukraine, in the recently liberated town of Lyman, Donetsk region, Ukraine, October 5, 2022. Credit: REUTERS/Zohra Bensemra.

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Standfirst

Four years into the full-scale invasion of Ukraine, the Russian military industry has entered a period of managed degradation. Russian authorities must constantly manage output constraints and industrial bottlenecks. While the drone segment has shown adaptability and resilience, the rest of the military industry must consider simplifying production across parts of the military-industrial complex.

Executive Summary

- This paper assesses Russia's near-term domestic defense-industrial capacity and the ability of the military-industrial complex (OPK) to meet the increasing demands of the war against Ukraine.
- Four years into the full-scale invasion of Ukraine, Russia has not solved the problem of sustaining wartime production. Instead, the Kremlin has only postponed addressing the OPK's many problems.

Output constraints and resilience

- Output constraints are increasingly defining the OPK's future: exhaustion (specifically, the depletion of existing stockpiles and the constant need to repair damaged equipment and refurbish Soviet-legacy hardware taken out of storage) and attrition (the limited ability to produce new military hardware domestically faster than it is consumed).
- Finding a balance between the two constraints has allowed the armed forces to continue fielding equipment, but it has also accelerated the depletion of Soviet-era reserves. However, the constant trade-off has become a systemic condition that defines the current and future trajectory of the military industry. The OPK cannot indefinitely compensate for battlefield losses through repair and refurbishment alone.
- Output constraints are compounded by industrial bottlenecks affecting raw materials and components paramount to the production of finished weapons systems. These persistent industrial bottlenecks are machine-building tools, military-grade metallurgical products and special steels, specialized components and chemicals for the manufacture of explosives, as well as microelectronics and semiconductors.
- The OPK has also demonstrated adaptability and resilience, notably in the aerial drone sector. Russia has rapidly expanded its use of reconnaissance drones, loitering munitions, first-person view (FPV) drones, and larger strike unmanned aerial vehicles (UAVs), turning drones into a central pillar of battlefield strategy. This shift reflects both military necessity and industrial opportunity, leading to a "dronization" of the OPK.

Managing military-industrial degradation

- Russia has expanded production across the defense sector by pushing factories into surge production, but this has not produced a corresponding leap in genuinely new output. This uneven resilience has been visible in key sectors such as armored vehicles, artillery systems, missiles, and aviation. Overall, the OPK is trading off sustained quantitative output for qualitative degradation.
- Despite evident adaptations, the OPK may be approaching a systemic tipping point. Existing legacy stockpiles are finite; modernization, renovation, and overhaul (MRO) is increasingly unsustainable; and increased production is degrading the same tools and inputs needed to sustain output. This tipping point, however, is not uniform across industrial sectors: It may emerge earlier in heavy equipment, for instance, or later in areas where the OPK retains advantages (such as missile systems and drones).
- The Russian OPK is trapped in a cycle in which increased production weakens its future production capacity. The result is a model of managed degradation of the Russian military industry, one that allows Moscow to sustain the war in the short to medium term, while progressively eroding the quality, sustainability, and future potential of its military power. Moving forward, the Kremlin will have to manage the OPK's decline rather than reverse it.
- The Russian OPK is adapting tactically, while structurally deteriorating. It can manufacture enough weapons to continue prosecuting the war, but increasingly only by simplifying production, lowering quality, and ultimately sacrificing long-term capacity for short-term battlefield endurance.
- The Russian state may need stronger administrative control over the economy and budget priorities to preserve wartime production at current levels. Even then, the likely outcome is not a revitalized military-industrial complex, but a narrower, simplified one that can muddle through rather than truly regenerate.

Introduction

Mainstream media appear convinced that Russia is soon running out of missiles, tanks, or drones and will no longer be able to prosecute the war against Ukraine.[1] Although such wishful thinking would likely benefit Ukraine, the Kremlin maintains high rates of fire against Ukrainian positions on the front line.

Four years into the full-scale invasion, the Kremlin's war still unfolds unabated. Official propaganda says it all: Russia is constantly increasing the volume of production "for all types of weapons by multiple times," has a "good reserve" of stock, or enjoys production capacity that is "overloaded."[2]

It is true that the Russian military-industrial complex (*oborónno-promýshlenny kómpleks,* OPK) benefits from the transition to a state-led war economy or "military Keynesianism."[3] The militarization of the economy means that, in 2026, defense spending should account for over 7.3% of GDP, with over 40% of the federal budget allocated to military, defense, and security-related expenditures.[4]

In this sense, the "separation" of the federal economy between the military sphere and civilian industries has never been stronger.[5] While the military and security sectors prosper, economic sectors not directly linked to the war effort are steadily declining.[6]

Increase of the arms production rates requires growing budgetary allocations and also leads to soaring total debt of companies within the OPK. Even though state-owned banks provided the absolute majority of loans for these entities at preferential rates, the low profitability of the sector makes debt repayment by the companies themselves impossible. Simply speaking, the federal budget will continue to be the major source of debt repayment, as it was in the pre-war period.

Russia is also facing setbacks in the wartime management of the OPK. As the armed forces are eating up Soviet-era weapons stockpiles, the OPK faces the dual challenge of maintaining military strength while adapting to new production realities. Western and Ukrainian assessments tend to be both cautious and optimistic about the existing Soviet-legacy stockpiles and reserves stored across the Russian Federation.

The OPK has adapted to the demands of the full-scale war since 2022 and to the pressure of international sanctions since 2014. It implemented domestic measures, such as import-substitution programs and higher production rates across the industry, along with increased cooperation with foreign countries.



Image: Russian Defence Minister Sergei Shoigu inspects implementation of the state defence order at a military-industrial complex facility in the Nizhny Novgorod region, Russia, in this picture released April 6, 2023. Credit: Vadim Savitsky/Russian Defence Ministry/Handout via REUTERS.

Despite limited resources and growing labor and industrial bottlenecks, Russia's military elites have also thus far shown resilience and adaptability in the face of mismanagement, corruption, and significant hardware losses.

On top of these adaptations, the demands of the war force the Kremlin to arbitrate between three imperfect internal solutions:

- Drawing down Soviet-era stockpiles,
- Repairing and refurbishing old equipment,
- Pushing factories to work harder under wartime conditions and under existing industrial bottlenecks.

Yet these domestic adaptations mask a deeper structural decline of the OPK. Each of those solutions helps the Kremlin buy time, but none of them can rebuild durable industrial capacity. Four years into the full-scale invasion of Ukraine, Russia has not solved the problem of sustaining wartime production. Instead, the Kremlin has only postponed addressing the OPK's many problems.

Two main factors are now defining the future of the OPK as it manages its own degradation. On the one hand, **output constraints**, which are determined by a precarious balance between:

- **Exhaustion**, specifically the depletion of existing stockpile inventories and the constant need to repair damaged equipment and refurbish Soviet-legacy hardware taken out of storage,
- **Attrition,** namely the limited ability to produce new military hardware domestically faster than it is consumed.

Finding a balance between both constraints defines the current and future trajectory of the OPK.

On the other hand, **input bottlenecks**, namely, industrial limitations affecting the aforementioned output in various sectors of the OPK and hampering overall production.

In the context of the upcoming State Armament Program (GPV) for the period 2027–2036,[7] the management of these factors will impact the sustainability of the OPK over the coming decade.

About this paper

To unpack this compound issue, the paper delivers a sober assessment of Russia's near-term domestic defense-industrial capacity and the military elite's ability to manage the degradation of the OPK. It looks specifically at:

- The most critical defense-industrial needs in the context of the OPK's balancing between refurbishment (exhaustion) and production of new systems (attrition) across key industrial bottlenecks, such as machine-building tools, metallurgical products, chemicals and gunpowder, and microelectronic components and semiconductors (Chapter 1),
- The impact of the war on the availability of finished systems across key military domains, such as armored land platforms, artillery shells, missile systems, and particularly drones (Chapter 2),
- In the drone segment, the adaptation and resilience of the OPK to sustain fighting strength while adapting to new production realities (Chapter 3).

For the purpose of this paper, our research focuses exclusively on domestic adaptations within the OPK, and not on how Russia has been managing the war effort with the help of foreign partners, external third parties, and sanctions-evasion mechanisms.

Chapter 1 – Battlefield exhaustion, hardware attrition, and military-industrial bottlenecks

Since 2014, the OPK has been adapting to international sanctions and the sustained demands of the invasion of Ukraine, particularly after 2022. Mitigation strategies have been developed against output constraints, notably to balance the management of existing stockpiles and strategic reserves through modernization, renovation, and overhaul (MRO) on the one hand, and seeking to increase domestic production volumes of new systems on the other to avoid attrition.

Beyond supply chain adaptations and stockpile management, the OPK has been facing challenges in sourcing and transforming raw materials and components to create finished weapon systems — primarily machine-building tools, special steels and military-grade metallurgical products, heavy chemicals and gunpowder, and microelectronic components and semiconductors. This situation has created industrial bottlenecks across several key systems, notably armored land platforms, artillery shells, missile systems, and aerial drones.

1.1 Domestic adaptations to output constraints

Since the first invasion of Ukraine in 2014, the Russian OPK has adapted to ongoing battlefield demands, finding a precarious balance between managing the existing stockpile of hardware and components to avoid exhaustion and increasing domestic production of new systems to prevent attrition. Several adaptations and strategies were put in place.

Stockpile management and refurbishment

Moscow entered the war against Ukraine in 2014 with the hope that its large stockpile of hardware, components, and raw materials would sustain the demands of the invasion. The full-scale invasion in 2022 dashed these hopes, however, and the Kremlin quickly resorted to using stock earmarked for 2024–25 production as early as 2023.[8] Nevertheless, this situation affected equipment deliveries for the subsequent state defense orders (GOZ).[9]

To an extent, depleting existing stockpiles served as a quick-fix initial solution aimed at meeting the demands of the war during the initial phases of both invasions in 2014 and in 2022–2023.[10] For instance, the armed forces began depleting their stockpile of precision-guided munitions (PGMs) at the onset of the war to achieve strategic effects against Ukrainian positions. The Kremlin noted the risk of running

out of high-end components after 2015, which forced the armed forces to change tactics.[11]

Soviet-inherited stockpiles were also removed from storage. The Kremlin decided to activate Soviet-era reserve mobilization capabilities: These "emergency reserves" had been dormant in storage bases across Russia since the 1970s and were mobilized to create stockpiles of ammunition, components, and materials.[12] However, it remains unclear how Moscow is managing existing reserves. Another issue with stockpile drainage is that many units fail to meet quality requirements and are unusable.[13]

Soviet legacy systems have been retrofitted and quickly upgraded.[14] Lower-quality and less precise equipment, such as T-54 and T-55 main battle tanks, still entered active service, only to be destroyed in Ukraine.[15] This situation forced the army to abandon many pieces of equipment on the battlefield.[16] However, the presence of legacy systems helps Russia saturate the front line and create a mass effect.[17]

Another form of stockpile management is to tap into the limited potential of civilian equipment that was cannibalized to support the OPK — from household appliances to passenger aircraft.[18] Stocks are more widely available than purely military ones, but their applications are circumscribed.

To this day, the bulk of domestic adaptation consists of the modernization, renovation, and overhaul (MRO) of existing platforms, whether in active service or in reserve storage. A vast campaign of MRO and refurbishment has been underway across the military industry since 2014 and accelerated in 2022. Entire weapon systems are stripped for parts and cannibalized to support existing platforms. The aim is to either refurbish, repair, and/or "modernize" the platforms.[19] Research has shown that as early as 2024, "most equipment sent to Ukraine is refurbished Soviet-era equipment," with only 25% of platforms newly produced.[20]

"Modernization" is a loaded term in the OPK. Russia generally favors upgrading existing and legacy platforms to make them look modern instead of producing entirely "new" systems.[21] Modernization must be understood as a "gap filler" aimed at extending the active service life of hardware.[22]

The invasion of Ukraine has put considerable strain on the Material-Technical Services (MTO) of the Russian armed forces, especially for battlefield repair.[23] Repair facilities have been deployed directly in the field to increase MRO turnaround through quick-fix repairs of damaged equipment. This allowed ground troops to maintain a higher operational tempo in Ukraine. However, the efficiency of MTO specialists was challenged by systemic issues such as outdated recovery equipment, breakdowns in the railway network, delays, and a lack of personnel.[24]

Shortfalls in maintenance for operational logistics, supply support, and overall MRO further complicated Russian sustainment in the field, especially for artillery systems.[25] The situation was also compounded by a "limited number of storage facilities and factories that specialize in restoring equipment from the reserves." [26] Another key aspect of Soviet stockpile management is the vast network of military transport, logistics, resupply nodes, and storage facilities scattered throughout the country, which has also been under strain since 2022.[27]

Soviet stockpiles, however, are not unlimited and are showing signs of irreversible depletion. 2025 will be the last year Russia will rely on legacy reserves, especially for artillery ammunition, main battle tanks, and armored vehicles.[28] Data on shipments from storage bases also show that volumes of Soviet hardware, such as armored vehicles and artillery systems, are decreasing.[29] This situation will force the Kremlin to rely more on domestic production than on MRO to meet the demands of the war.

Domestic production

Besides stockpile management and MRO for existing platforms, Russia was forced to accelerate and expand military production across all sectors of the OPK to meet the demands of the war. Since 2014, the bulk of the Russian OPK has been on a war footing, ramping up domestic production. Most companies issued propaganda statements highlighting increased results, output, and efficiency.[30] However, the military industry was unable to achieve the "serial and uninterrupted production of military hardware" envisioned under surge production in the current State Armament Program (GPV).[31]

Adapting production chains and increasing output have been heavily impacted by well-known systemic ailments that chronically affect the OPK, including quality workforce deficiencies, lack of industrial coherence, financial and economic ailments, industrial overconcentration, or absence of quality control.[32] These issues continually limit Moscow's ability to prosecute the war and sustain the military industry in the long term.

The simplest solution for the OPK was to increase the pace of work and output across virtually all production chains. Companies created forced labor productivity by limiting paid holidays and days off, lengthening work shifts, introducing multi-shift work, and imposing other conditions such as forced overtime or six-day working weeks.[33] This "special mode of operation" of the OPK, however, was generally not accompanied by major increased salaries or employee compensation.

In turn, the situation does not incentivize workers to increase their productivity. Workforce productivity was never a strong suit of the OPK, but the demands of the war only worsened the situation. No amount of state-sponsored propaganda can

Figure 1: Rostec Labor Productivity per Employee (constant prices of 2021)

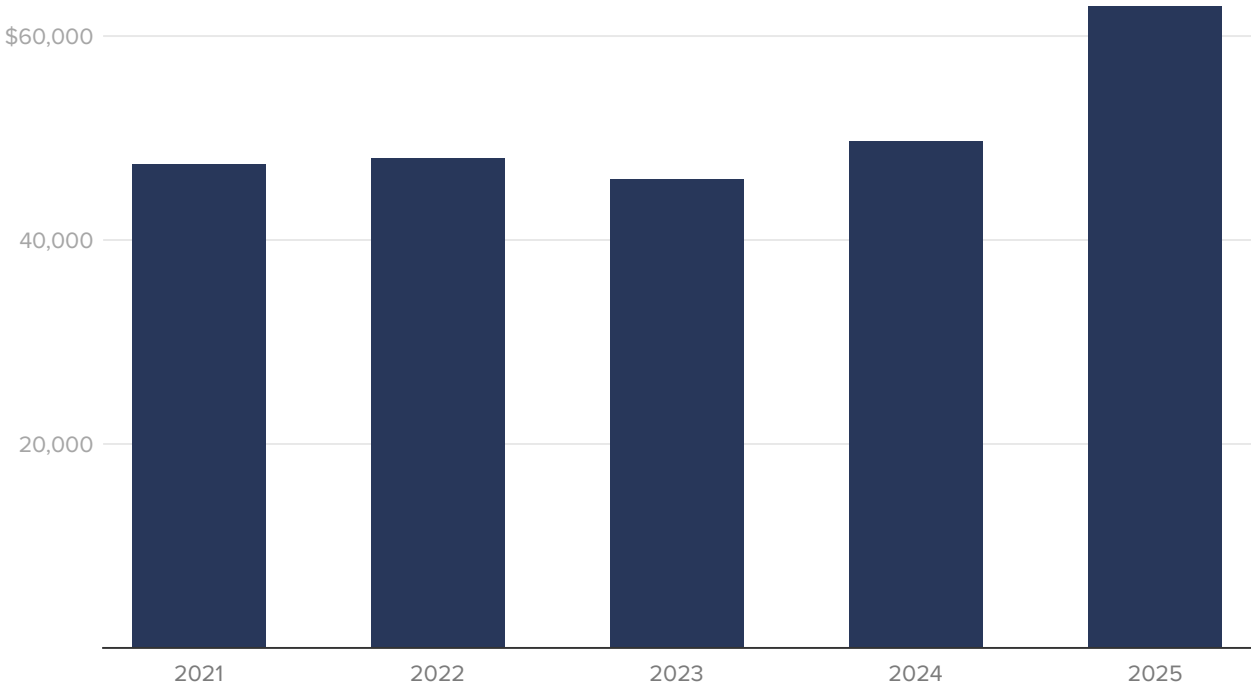


Chart: Center for European Policy Analysis • Source: «Встреча с главой госкорпорации "Ростех" Сергеем Чемезовым" ("Meeting with the head of state-owned corporation "Rostec" Sergei Chemezov"), Kremlin.ru, May 18, 2022, http://kremlin.ru/events/president/news/68437; "Встреча с главой госкорпорации "Ростех" Сергеем Чемезовым" ("Meeting with the head of state-owned corporation "Rostec" Sergei Chemezov"), Kremlin.ru, June 17, 2025, http://kremlin.ru/events/president/news/77194; "Росстат представляет первую оценку ВВП за 2025 год" ("Rosstat presents the first assessment of GDP in 2025"), Federal State Statistics Service, February 6, 2026, https://rosstat.gov.ru/folder/313/document/277380; "Встреча с главой госкорпорации "Ростех" Сергеем Чемезовым" ("Meeting with the head of state-owned corporation "Rostec" "Sergei Chemezov"), Kremlin.ru, May 7, 2026, http://kremlin.ru/events/president/news/79695.

make up for poor working conditions, non-competitive salaries, and the absence of a managerial culture.[34]

For instance, the number of Rostec employees increased by 23% between 2022 and 2025, from 591,000 to 727,000 employees.[35] This number does not solely come from recruiting but encompasses the number of OPK entities that became Rostec subsidiaries during that time. For example, many state-owned gunpowder and explosives industries were transferred to Rostec, including some 30,000 employees. Simultaneously, the average gross monthly salary of Rostec employees doubled from 61,600 rubles per month ($836) to 115,200 rubles per month ($1,384), and their labor productivity, taken as revenue per employee, increased by 78%, from almost 3.5 million rubles ($47,381) to 6.2 million rubles ($62,887).[36]

Figure 2: Average Gross Worker Salary at Rostec



Chart: Center for European Policy Analysis • Source: «Встреча с главой госкорпорации "Ростех" Сергеем Чемезовым" ("Meeting with the head of state-owned corporation "Rostec" Sergei Chemezov"), Kremlin.ru, May 18, 2022, http://kremlin.ru/events/president/news/68437; "Встреча с главой госкорпорации "Ростех" Сергеем Чемезовым" ("Meeting with the head of state-owned corporation "Rostec" Sergei Chemezov"), Kremlin.ru, June 17, 2025, http://kremlin.ru/events/president/news/77194; "Росстат представляет первую оценку ВВП за 2025 год" ("Rosstat presents the first assessment of GDP in 2025"), Federal State Statistics Service, February 6, 2026, https://rosstat.gov.ru/folder/313/document/277380; "Встреча с главой госкорпорации "Ростех" Сергеем Чемезовым" ("Meeting with the head of state-owned corporation "Rostec" Sergei Chemezov"), Kremlin.ru, May 7, 2026, http://kremlin.ru/events/president/news/79695.

However, these numbers represent current prices and do not consider inflation. If we take into account the monetary inflation and official price deflator provided by the Russian statistics bureau during the years of the war, the picture would be much more moderate. Even the exceptional growth of revenue and labor productivity in 2025 exceeding Rostec's own forecast of August 2025 derives from the fact that it got an additional 500bn rubles ($6bn) either after the revision and increase of the national defense budget in fall 2025 or retroactively in early 2026.[37] Briefly speaking, Rostec planned to get 4 trillion rubles of revenue in 2025 and suddenly got 4.5 trillion rubles.

Figure 3: Rostec Revenue

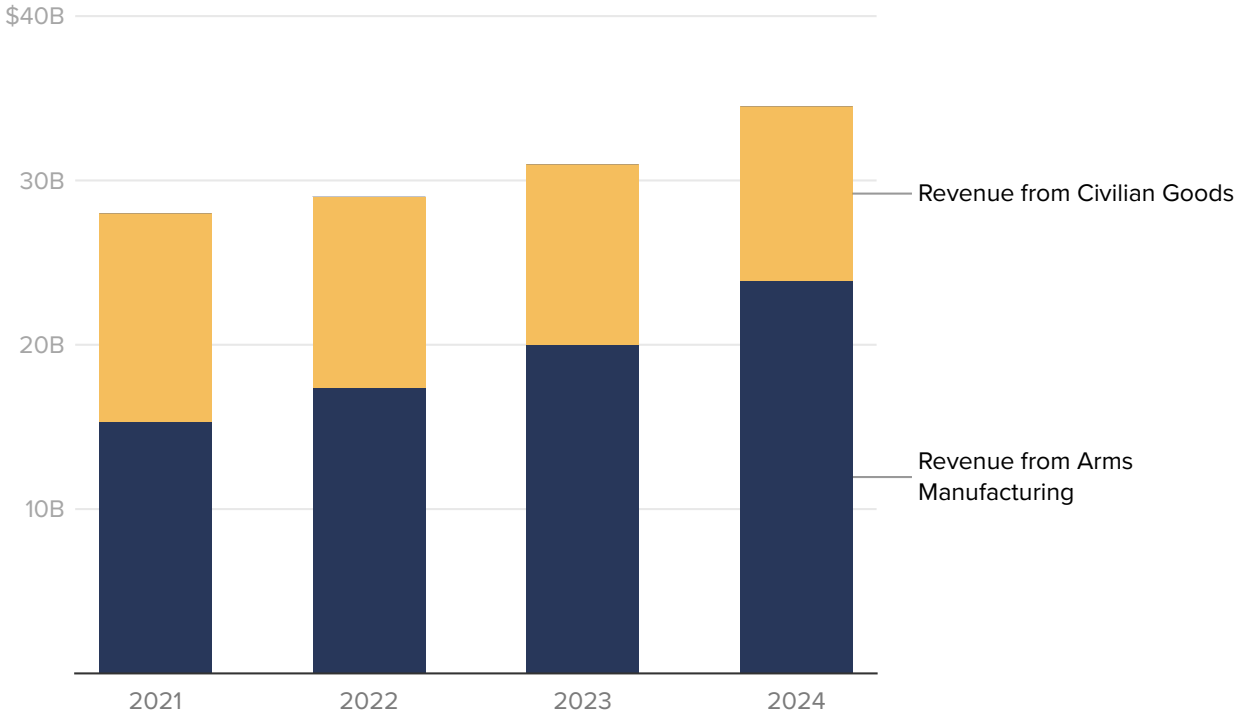


Chart: Center for European Policy Analysis • Source: "Встреча с главой госкорпорации "Ростех" Сергеем Чемезовым" ("Meeting with the head of state-owned corporation "Rostec" Sergei Chemezov"), Kremlin.ru, May 18, 2022, http://kremlin.ru/events/president/news/68437; "Встреча с главой госкорпорации "Ростех" Сергеем Чемезовым" ("Meeting with the head of state-owned corporation "Rostec" Sergei Chemezov"), Kremlin.ru, June 17, 2025, http://kremlin.ru/events/president/news/77194; "Росстат представляет первую оценку ВВП за 2025 год" ("Rosstat presents the first assessment of GDP in 2025"), Federal State Statistics Service, February 6, 2026, https://rosstat.gov.ru/folder/313/document/277380; "Встреча с главой госкорпорации "Ростех" Сергеем Чемезовым" ("Meeting with the head of state-owned corporation "Rostec" "Sergei Chemezov"), Kremlin.ru, May 7, 2026, http://kremlin.ru/events/president/news/79695.

Workforce deficiencies and human capital issues have increased in the OPK since 2014, amid the war against Ukraine, the impact of COVID-19, and international sanctions. These issues generally relate to:

- Lack of qualified and trained workers. The government itself acknowledged the issue, claiming a shortfall of 400,000 workers in 2022, representing about 20% of total OPK employees, against "only" 160,000 in 2024.[38]
- Recruitment. While military conscription and mobilization have complicated overall recruitment, the OPK remains unattractive for junior engineers and

specialists.[39] Young graduates generally do not see the OPK as a source of prestige or career development.

- Brain drain. The full-scale invasion of Ukraine accelerated the ongoing trend of the exodus of young professionals from Russia, especially in the IT sector and applied sciences.[40]
- Age gap. The average age of engineers in design bureaus and research centers is over 70 years old, which does not incentivize young staff to foster a culture of innovation and modernity.[41]
- Education. The root cause of the problem is that the quality of higher scientific and technical education in Russia has plummeted since the collapse of the Soviet Union, leading to a loss of intellectual capital.[42]

Another attempt to boost domestic production was the creation of "import substitution" programs in 2014 to replace imported components with locally produced ones and streamline internal procurement.[43] Two programs were established in 2014, with an initial target of substituting 85% of imported military components with domestically produced ones by 2025.[44] The programs, unsurprisingly, were a complete failure, largely due to the inability of production chains to cope with increased output, as well as cost control issues and inadequate state assistance.[45]

Finding the "tipping point" in domestic adaptations?

In constant prices of 2021, Rostec's revenue increased by 49%, including more than doubled revenue in arms manufacturing. However, labor productivity increased by only 20% considering the additional budget transfer of 2025 (without this, the labor productivity would be just 8% higher by the end of 2025 compared to 2021). This essentially means that increased revenue from arms manufacturing mostly stems from cost inflation, stockpile use, and MRO rather than from dramatic increases in new output.

Overall, the OPK is struggling to adapt to more demanding production cycles for new systems and constant MRO of existing platforms. Over a decade of war against Ukraine has shed light on the unsolvable equation Russia is facing:

- With the exception of the drone segment (*see Chapter 3*), experts agree that the OPK has reached its current limits in producing new equipment.[46] Indeed, the industry's capacity to expand, upgrade, and create new production chains is finite.
- Existing stockpiles are also finite, especially as depletion looms for the larger Soviet legacy platforms.[47]
- Continuous and sustained MRO on existing and refurbished platforms is pushing equipment to the point of failure. There is a limit to constantly tinkering with second-hand hardware.

- Increased output and renovation degrade production tools, which are themselves mostly imported (especially machine-building tools, *see below*).

The Kremlin now faces the consequences of a constant trade-off between pushing production chains, while managing the depletion of existing stockpiles and the degraded ability to maintain battle-fatigued platforms.

This situation raises the question of whether there is a "tipping point" at which the armed forces will lose equipment faster than the OPK can produce and repair it.[48] Once that tipping point is crossed, the OPK's output might collapse in certain segments and fail to meet the demands of the war, thereby leading to genuine hardware exhaustion and depletion. Indeed, the OPK's ability to increase output of new systems depends on the same factors that limit MRO in the first place.

The long-term consequence is that the *quality* of Russian military systems will degrade. This situation will likely force the OPK to simplify its output and limit production to known, less advanced systems, with lower quality, quantity, and production rates. Simplification of military-industrial production will also lead to stagnation of the OPK, if not regression, especially for more advanced systems.[49]

To counterbalance, Moscow has been relying on foreign partners and third-country imports. Yet this solution will not solve the OPK's issues and help achieve an acceptable trade-off in the long term. Russia will ultimately have to rethink the future of the OPK on its own.

1.2 Industrial bottlenecks: raw materials and critical components

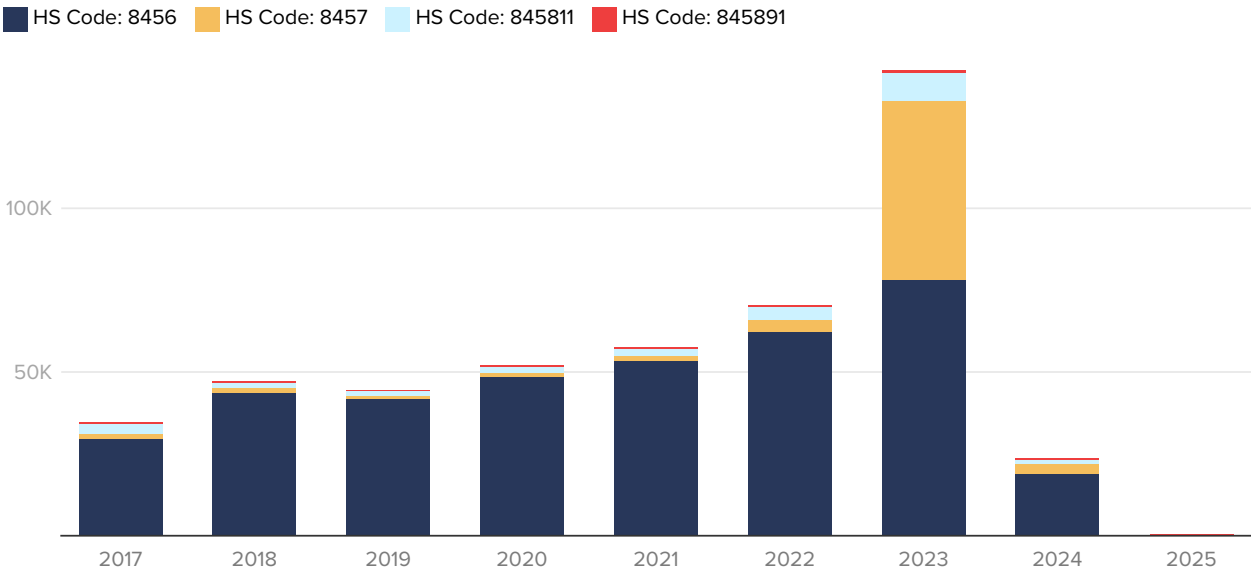
Given the limits of domestic adaptations, the entry point of the entire OPK production chain has been experiencing setbacks, thereby limiting increases in industrial output. The war amplified preexisting "Achilles' heels" and input bottlenecks in diverse sectors of the military industry, and particularly for machine-building tools, special steels and military-grade metallurgical products, heavy chemicals and gunpowder, and microelectronic components and semiconductors.[50]

Machine-building tools

Specialized production tools for military hardware manufacturing include machine-building tools, such as metalworking machine tools, laser-cutting tools, lathes, and computer numerical control (CNC) machine tools.[51] The OPK uses the vast majority of machine tools available in Russia. Increased production tempo and output since 2014 have placed these machines under strain, with a constant risk of breakdown and a scarcity of spare parts to repair them.

Figure 4: Import of machine tools into Russia

2017–2025



Numbers for 2025 available at the source. HS Code 8456: Machine tools; for working any material by removal of material, by laser or other light or photon beam, ultrasonic, electro-discharge, electro-chemical, electron beam, ionic-beam, or plasma arc processes; water-jet cutting machines. HS Code 8457: Machining centers, unit construction machines (single station) and multi-station transfer machines for working metal. HS Code 845811: Lathes; for removing metal, horizontal, numerically controlled. HS Code 845891: Lathes; for removing metal, numerically controlled, other than horizontal lathes. Source: UN ComTrade Database.

The issue for Moscow is that up to 90% of machine tools and associated spare parts used in Russia were imported from Germany, Switzerland, Italy, Japan, Taiwan, and the United States until the late 2010s.[52]

Starting in 2022, the situation changed dramatically and China became a dominant supplier: Beijing's share in machine tool supplies increased from 13% in 2017 to 80-90% after 2022. Türkiye and India have begun to play a visible role in the supplies of machine tools to Russia as well.

A critical issue is that the tools and spare parts needed to manufacture Russian-made machine-building tools are themselves originating from the same countries.[53] Despite timid attempts at import substitution through domestic production, Russia was never able to reduce its overdependence on foreign suppliers.

Import substitution through domestic production of machine tools began in 2011, strengthened in 2015 amid the first invasion of Ukraine, and reached a peak in 2020, with a full-fledged strategy for domestic development.[54] In 2025, Russia initiated

Table 1: Top-10 supplier countries of metal-working machine tools to Russia in 2017-21

Supplier Country	HS 8456	HS 8457	HS 845811	HS 845891	TOTAL
Germany	$124,156,557.00	$289,518,121.00	$129,349,473.00	$58,985,752.00	$602,009,902.00
China	$276,478,146.00	$110,620,708.00	$115,634,644.00	$12,179,303.00	$514,912,801.00
Taiwan	$12,836,276.00	$168,038,084.00	$104,304,759.00	$45,998,715.00	$331,177,834.00
Japan	$25,923,737.00	$70,497,016.00	$78,239,592.00	$8,960,781.00	$183,621,126.00
Italy	$41,801,984.00	$59,432,416.00	$39,748,763.00	$32,803,644.00	$173,786,807.00
Switzerland	$53,439,570.00	$82,532,265.00	$16,458,551.00	$139,798.00	$152,570,184.00
Republic of Korea	$2,348,170.00	$36,998,167.00	$81,749,170.00	$20,484,746.00	$141,580,253.00
Austria	$3,891,469.00	$2,886,952.00	$97,898,698.00	$373,889.00	$105,051,008.00
Czech Republic	$13,924,691.00	$48,828,239.00	$18,198,719.00	$17,331,098.00	$98,282,747.00
Poland	$10,049,680.00	$36,827,937.00	$23,636,946.00	$4,566,942.00	$75,081,505.00

HS Code 8456: Machine tools; for working any material by removal of material, by laser or other light or photon beam, ultrasonic, electro-discharge, electro-chemical, electron beam, ionic-beam, or plasma arc processes; water-jet cutting machines. HS Code 8457: Machining centers, unit construction machines (single station) and multi-station transfer machines for working metal. HS Code 845811: Lathes; for removing metal, horizontal, numerically controlled. HS Code 845891: Lathes; for removing metal, numerically controlled, other than horizontal lathes.
Table: Center for European Policy Analysis • Source: UN ComTrade Database.

Table 2: Top-10 supplier countries of metal-working machine tools to Russia in 2022-25

Supplier Country	HS 8456	HS 8457	HS 845811	HS 845891	TOTAL
China	$461,913,718.00	$675,259,991.00	$478,221,055.00	$73,888,590.00	$1,689,283,354.00
India	$3,674,631.00	$108,437,853.00	$41,076,640.00	$6,949,334.00	$160,138,458.00
Turkiye	$31,093,590.00	$49,961,111.00	$54,845,083.00	$8,503,848.00	$144,403,632.00
Republic of Korea	$947,708.00	$24,487,383.00	$93,369,864.00	$20,312,743.00	$139,117,698.00
Taiwan	$20,080,027.00	$55,452,034.00	$27,942,650.00	$9,060,701.00	$112,535,412.00
Kazakhstan	$2,253,256.00	$26,535,952.00	$14,295,776.00	$4,589,776.00	$47,674,761.00
Germany	$730,682.00	$8,867,568.00	$13,912,090.00	$7,547,147.00	$31,057,488.00
Italy	$4,902,459.00	$13,607,014.00	$2,163,423.00	$2,616,251.00	$23,289,147.00
Spain	$923,336.00	$3,127,458.00	$1,026,944.00	$1,364,763.00	$6,442,501.00
Japan	$876,917.00	$295,137.00	$2,697,194.00	$0.00	$3,869,248.00

Note: Data for 2025 was still incomplete during the work on this report. Most supplies from Germany, Italy, Japan, South Korea, Spain and Taiwan ended in 2022 as well as from the other European countries and the United States that were not included in this rating because of lower amounts of supplies. Some minor supplies from the mentioned countries took place in 2023, and there are no visible direct supplies after 2023. However, Russia still tries to use minor intermediary jurisdictions like Armenia, Kyrgyzstan, Thailand and so on for smuggling import of small batches of advanced metal-working machine tools. HS Code 8456: Machine tools; for working any material by removal of material, by laser or other light or photon beam, ultrasonic, electro-discharge, electro-chemical, electron beam, ionic-beam, or plasma arc processes; water-jet cutting machines. HS Code 8457: Machining centers, unit construction machines (single station) and multi-station transfer machines for working metal. HS Code 845811: Lathes; for removing metal, horizontal, numerically controlled. HS Code 845891: Lathes; for removing metal, numerically controlled, other than horizontal lathes.
Table: Center for European Policy Analysis • Source: UN ComTrade Database

another national project to develop automation tools (including for machine tools and industrial robotics) with the unrealistic aim to reach 60% of domestic production by 2030.[55]

For the past decade, indigenous machine tool production has been increasing. Propaganda announcements make a point of showing domestic results that vastly exceed official goals and of expanding growth.[56] This did not prevent internal voices from criticizing government policies, arguing that the "country's machine tool industry has been destroyed."[57]

Some level of innovation remains in the machine tool industry.[58] Yet domestic efforts have all largely failed. Some 400 machine tool manufacturing companies operate in Russia, accounting for a meager 8% of the OPK's needs.[59] Russian-made machine tools are generally considered to have "low complexity" compared to their foreign counterparts, and their construction is never made with domestically produced parts only.[60] The OPK has few internal alternatives: Cannibalizing civilian machines or reverse-engineering foreign equipment has proven limited.[61]

Incapable of meeting internal demands for high-quality domestic machine-building tools, Russia has no choice but to rely fully on foreign partners and third-country imports outside the sanctions regime. In other words, China. For about a decade, Beijing has become the main provider of machine-building tools, especially CNC machines and associated components for the Russian OPK.

The "sinicization" of Russia's machine tool industry

If production rates of machine tools more than doubled in 2022–2025 compared to the pre-2022 period, the number of employees in the sector only increased by 28%. Moreover, there were 26,800 employees and 23,600 employees in the sector in 2010 and 2011, respectively. More recent estimates show that Russia can manufacture 1,500–1,700 machine tools a year.[62]

From this contradiction, it can be surmised that either Russian manufacturers import units from abroad (mostly from China) and sell them as "Russia-made," or they import parts and components to carry out final assembly on Russian soil. In both cases, the situation leaves the OPK highly dependent on China, thus creating a "sinicization" of that particular industry.

Chinese machine tools today account for about 90% of imported units. Beijing has become Russia's "safety net," but the situation is merely replacing a foreign supply-chain overdependence with another.[63] To circumvent sanctions, alternative transshipment routes and evasion schemes have also flourished, including through Taiwan.[64]



Image: An employee works in a copper electrolysis workshop of Kola Mining and Metallurgical Company (Kola MMC), a subsidiary of Nornickel metals and mining company, in the town of Monchegorsk in Murmansk Region, Russia February 25, 2021. Credit: REUTERS/Evgenia Novozhenina.

Chinese and non-Western machine tools, however, are of lower quality and do not fully meet the OPK's precision requirements and standards. To compound the issue, Beijing is also careful not to export its most advanced CNC units: In October 2025, China tightened export rules for machine tools with three- to four-micron precision.[65]

The current situation leaves Russia technologically isolated. As aging Western-made units start to break down, spare parts will become scarce, and the machines will become unusable over time. As the OPK extends the operational life cycle of Western machine tools, it will have to arbitrate the use of spare parts.[66]

Chinese alternatives will never fully fill the gap, especially for more advanced machining. The average cost of imported machine tools from China is lower than Western counterparts, showing that quantity and availability of machine tools seem to be more important for Russia than their quality.

Furthermore, Russia has few alternatives to diversify third-party imports besides China, and imported components are also increasing the cost of domestic machine

tools.[67] Ultimately, OPK companies might have to scale back production tempo and output altogether, leading to genuine industrial exhaustion.

Metal, special steels, and metallurgical products

Production of military-grade metallurgical products (special steels, reinforced steel and iron, prefabricated steel products, bearings, etc.) increased amid the invasion of Ukraine, with all main production clusters showing output growth.[68] However, since at least 2024, numbers have been declining in both the civilian and military-grade segments.[69]

As in other sectors, the armed forces initially tapped into the vast Soviet legacy stockpiles and cannibalized existing armor, chassis, and hulls for heavy infantry vehicles and ground vehicles. The issue is that armored steels used in older models have been known to be heavier when fitted onto more modern platforms, leading to transmission breaking.[70] Furthermore, military-grade special steels are only as good as the machine-building tools behind them, a sector where Russia lags (*see above*).

Russia has been facing a shortage of ball bearings supporting axial loads on heavy ground platforms. The civilian industry and the OPK have been historically dependent on Western-made bearings (Germany, US, etc.), leading to few available stockpiled items.[71] Russian-made production accounts for less than 25% of domestic needs.[72] Third-country alternatives, mostly from China and Malaysia, generally do not meet quality standards for the Russian industry. Because Moscow procures only lower-quality bearings, the quality of heavy infantry vehicles will continue to degrade.

Russia still heavily depends on foreign aluminum production and imports. A recent Organized Crime and Corruption Reporting Project (OCCRP) investigation shed light on how the Ireland-based plant Aughinish Alumina has continued exporting its alumina output to Russia, where the ore is then processed, transformed into aluminum, and dispatched to arms manufacturers throughout the country.[73]

Overall, the war and sanctions have significantly affected the metallurgical sector, meaning the quality of Russian armor will continue to degrade for the foreseeable future. With shortages of explosive reactive armor (for instance, for the new Relikt system), Russian ground systems will become more vulnerable to missile strikes and loitering drones. This situation will gradually lead to exhaustion as the ability to repair ground platforms further diminishes.

Chemicals and gunpowder production

Missile systems and artillery shells are only the sum of their parts, namely specialized chemicals and cotton. The production of artillery shells and gunpowder appears to be the sector where the OPK experienced the fewest setbacks during the full-scale invasion.

Chemicals used to manufacture explosives have not been significantly affected, not least because of Russia's historically large chemical and fertilizer production sectors. The production of specialized chemicals for explosives manufacturing (gunpowder and propellants) such as toluene, ammonium nitrate, and concentrated nitric acid has been steadily increasing since the 2010s.[74]

The majority of special chemical plants working for the OPK were moved under the management of Rostec in 2023 to consolidate the segment in the context of the war.[75] Industry leaders include UralChem, its subsidiary Azot, and EuroChem, which provide essential support to the OPK.

The main bottleneck in that segment lies with the production of concentrated nitric acid. Only two factories produce this chemical component: the Azot factory in Berezniki in the Perm region, belonging to UralChem and responsible for two-thirds of total production, and the Azot factory in Novomoskovsk in the Tula region, belonging to EuroChem. A Ukrainian drone attack on the Azot factory located in Novomoskovsk, Tula oblast, in June 2025 resulted in a temporary twofold reduction of the monthly output in June–July. However, the plant managed to quickly restore and even increase production rates compared to previous years.[76]

The manufacturing of solid propellant for missiles has also not experienced major shortages, thanks to the solidity of Russia's heavy chemical industry. Many propellant manufacturers expanded their production chains.[77]

Yet annual production does not fully meet Russian warfighting needs, which explains why Moscow has been acquiring artillery shells from North Korea since 2023. The chemical industry has also been experiencing setbacks, notably due to Ukrainian drone strikes against the Research Institute of Applied Chemistry in Sergiyev Posad, the Krasnozavodsky Chemical Plant, and the Azot plant in Tula.

Gunpowder and artillery shell production doubled between 2022 and 2024, thanks to the expansion of production chains, the hiring of workers, and increased domestic manufacturing.[78] Industry leaders include the Kazan powder plant, which produces most of Russia's gunpowder, the Tambov gunpowder plant, and the Perm facilities.

The fastest-growing sector is cellulose: Cotton pulp is transformed into cotton cellulose in Russia and then chemically converted into nitrocellulose, used in propellants and gunpowder shells. Chemicals used to create nitrocellulose (pyroxylin and colloxylin), as well as wood-based cellulose, have not been in short supply.[79]

Russia has no shortage of cotton, either, although the bulk comes from foreign imports. Due to insignificant domestic cotton production, Russia is entirely dependent on imported cotton pulp and cellulose nitrate from Uzbekistan and Kazakhstan, as well as from India, Malaysia, and Türkiye, to a lesser extent. Uzbekistan and

Kazakhstan have been supplying over 98% of Russia's imported cotton pulp for years, with annual production increasing since 2022.[80] Nitrocellulose imports come in majority from Türkiye and China, with Turkish companies likely using sanctions evasion schemes to resell nitrocellulose produced in European countries.[81]

Thanks to imports, Russia created a three-year stockpile of cotton pulp between 2022 and 2024.[82] Even without imports, gunpowder production over the period 2025–2027 is unlikely to be altered. 2025 imports of cotton pulp have not been disclosed.

While unable to remove foreign dependency on cotton, the OPK is exploring alternatives, such as producing gunpowder from wood pulp (a raw material Russia is unlikely to run out of), linen, flax, and hemp fiber — although prospects are limited and not a suitable replacement for cotton.[83] Moscow is also expanding third-country linkages, for instance, by announcing plans to establish propellant production in India in 2024 for artillery systems.[84]

Figure 5: Manufacturing of some chemical components essential for gunpowder and explosive manufacturing

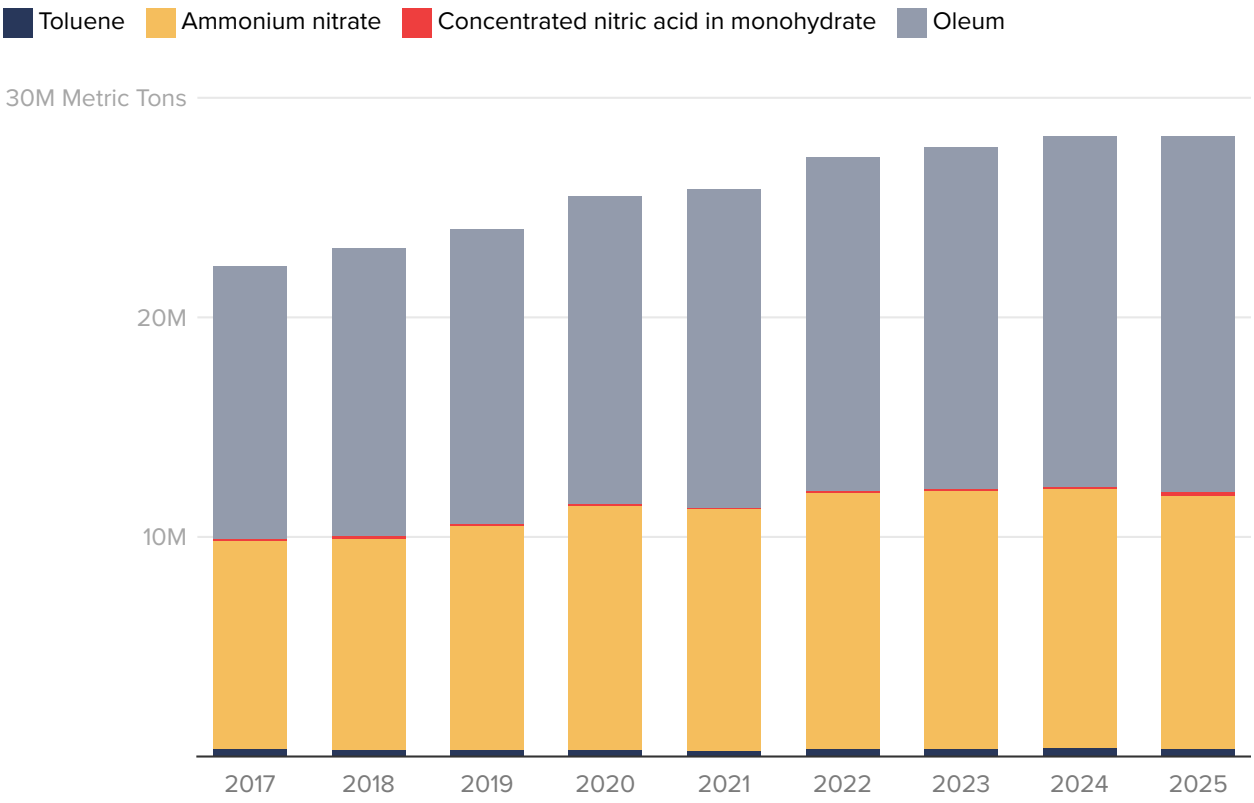


Chart: Center for European Policy Analysis • Source: The Federal Statistics Service of Russia (Rosstat).

Gunpowder manufacturing plants have experienced production setbacks since 2022, as Ukrainian drone strikes impacted the plant in Ryazan and the Kotovsky gunpowder plant in Tambov several times.[85]

Given the availability of chemicals and cotton, and the option to procure finished artillery shells from North Korea (from 8m to 11m in 2023–2025, including at least two batches of shells in January–March 2026[86]), Russia is unlikely to face battlefield ammunition exhaustion in the foreseeable future. Many manufacturing companies have been undergoing repair work and modernization amid the war, which means domestic output of gunpowder and artillery shells will likely increase in the next few years.[87] Without international targeted sanctions in the chemical and cotton sectors, Russia will continue manufacturing explosives and shells relatively unencumbered.

Microelectronic components and semiconductors

The manufacturing of advanced computer chips and semiconductors was never Russia's strong suit, nor was post-Soviet Russia ever a leader in the silicon-based economy. Modern military hardware requires complex microelectronic components that the OPK cannot produce in sufficient quantity or quality. This situation forces the Kremlin to import most of the required dual-use electronic components, microchips and microprocessors, advanced optical systems, and space-grade microelectronics components. This critical dependence on foreign-made components as part of the "silicon lifeline" is well documented. [88]

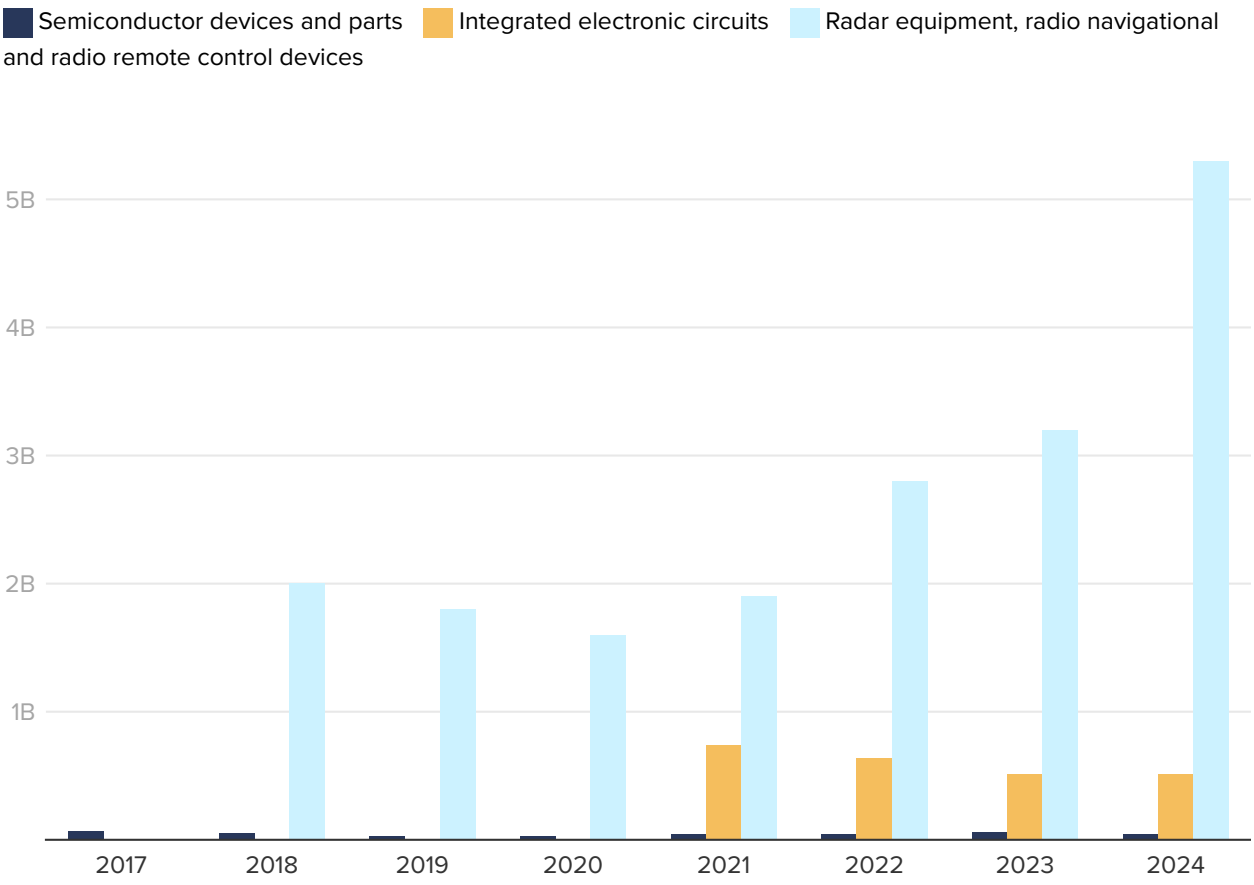
International sanctions forced Russia to replace its overreliance on Western-made microelectronics and chips with a new dependence on China. After 2014, Moscow initially faced supply chain disruptions and difficulties sourcing components. Western-made microelectronics and chips are increasingly replaced with Chinese-made components, with few alternatives in sight.[89] Iran was identified as a potential partner in the manufacture of lithographic machines, with the signing of a memorandum of cooperation in 2025 — although prospects are very limited,[90] not least in the context of the war.

Domestic production

Since 2014, Russia has been stockpiling foreign-made microelectronic components and chips to counter international sanctions.[91] Yet the demands of the full-scale invasion in 2022 forced Moscow to deplete the modest stockpile, with no possibility of rebuilding it domestically.

Public policy aimed at expanding Russia's nascent microelectronics industry has been largely inept. National projects for electronics and other federal endeavors have been underfunded and unachievable.[92] For instance, the goal of reaching 70% of import substitution for semiconductor equipment and raw materials by 2030 is

Figure 6: Manufacturing of electronic components used in military production



Note: These numbers can be revised by Rosstat later in 2026; the crucial part of this growth is defined by the cost plus inflation. Measured in billions. Chart: Polina Tsurikova/Center for European Policy Analysis • Source: The Federal State Statistics Service of Russia (Rosstat).

grossly unrealistic.[93] Government officials half-heartedly recognize that achieving "full sovereignty in microelectronics" is daunting.[94]

Meanwhile, industrial efforts to achieve import substitution through domestic production generally failed. The OPK has a few domestic companies that produce military-grade chips; they manufacture only Russian-made systems, notably communication and navigation devices, drones, and missiles.[95] These include Angstrem, Mikron, and Milandr, all located in Zelenograd outside Moscow. The companies, however, are unable to meet the bulk of military needs, and their yearly output is now declining.[96]

Russia's IT industry at large is backward compared to Western and Chinese standards, not to mention modern semiconductors and military-grade electronic components.[97] When it comes to microchip production, the official goal is to mass-produce 28-nanometer (nm) chips by 2028 and start manufacturing 14 nm microchips by 2030. However, major manufacturers cannot produce chips below 65 nm, with mass production only available for nodes larger than 130 nm.[98] Meanwhile, Western industry standards are edging toward the 1–2 nm order and beyond.[99] Current domestic production objectives remain two to three decades behind those of foreign industry leaders, even for basic civilian chips and microelectronics.

Domestic manufacturers heavily depend on Western equipment for photolithography; Russia remains unable to build its own photolithography machines to produce more advanced electronics. Only in 2025 did the Zelenograd Nanotechnology Center start developing domestic lithography equipment for 350 nm and 130 nm nodes, an event considered a "milestone" in Russia but well behind Western standards.[100] The same applies to wafer production for silicon wafers, with Rostec barely producing 150 mm and 200 mm silicon wafers.[101]

Several other issues further compound domestic production:

- Russian-made microelectronics suffer from a high defect rate and overall quality issues. Some accounts state that large percentages of output are unusable for military applications, further underscoring quality control issues crippling the OPK.[102]
- Domestic production cannot be sustained without foreign imports. Since 2014, international sanctions have severely constrained access to Western-made manufacturing equipment, tools, and essential components for domestic microelectronics.[103] Evasion schemes and illegal smuggling have not offset this loss of access, and the price of foreign equipment has increased at least tenfold.[104]
- Supply chain issues persist for raw materials used in microelectronics manufacturing, such as tantalum used for capacitors.[105]
- Imported components from non-Western sources have encountered integration issues in Russian military hardware, not least due to concerns about quality and integration requirements. Chinese-made electronics are more prone to defects and failures, and those sold to Russia are generally less advanced.[106]
- National investments in the IT sector are minuscule compared to those of peer competitors in the US and China.[107] A lack of funding is preventing the OPK (and the civilian industry alike) from establishing new production chains.
- Ukrainian drone strikes have affected Russian manufacturing companies. For instance, in January 2025, the Kremniy El plant halted production after a drone strike.[108]



Image: Russian President Vladimir Putin visits the 344th State Centre for combat use and retraining of flight crews of the Russian Defence Ministry in the town of Torzhok in the Tver Region, Russia March 27, 2024. Credit: Sputnik/Mikhail Metzel/Pool via REUTERS.

- Workforce deficiencies, like elsewhere, cripple the IT sector. Manufacturers have been trying to attract engineers with higher salaries, but the effects have not yet been felt.

Overall, there is little prospect that the Russian IT industry can become independent of Chinese imports and achieve self-sufficiency. Domestic production is likely to lag for the foreseeable future and fail to meet the demands of the armed forces. Without import substitution, the OPK will be forced to downgrade its production standards and remain stuck with older-generation manufacturing processes and equipment. As a result, Russia will produce less reliable systems that are more prone to misfires, errors, and accidents.[109]

Large quantities of basic imported chips from China remain widely available to the OPK. As long as Beijing continues exporting components, there is no reason to believe that Russia will face exhaustion. The majority of military systems require only such basic microelectronics.

For more complex or cutting-edge systems required for computerization and miniaturization of military hardware, however, Russia might experience a critical bottleneck. Foreign dependency and domestic IT backwardness will undoubtedly impact the evolution of key technologies with military applications and battlefield employment.

In the space sector, the manufacturing of space-grade electronics is struggling to keep up. Modern Russian satellites mostly use Western and Chinese components. At the same time, the Western components for heavy and medium communication, navigation, and Earth observation satellites orbited in 2022–2025 (11 spacecraft in total) and planned for orbiting in 2026–2030 (at least 18 spacecraft ordered in previous years)[110] were mostly purchased and stockpiled before 2022 and sometimes even before the first sanction rounds related to the annexation of Crimea of 2014 and to the Countering America's Adversaries Through Sanctions Act (CAATSA) of 2017.

Considering the dwindling stockpiles, Moscow is now adapting its space strategy and considering the production of mini- and microsatellites with shorter life cycles for communication and Earth observation purposes. These satellites are equipped with available China-made electronics instead of advanced space-grade electronics imported from Europe, the United States, and Japan.

In the field of military robotics and autonomy, the OPK might increase the cannibalization of civilian microchips and fail to acquire more advanced ones. However, while there have been reports about the use of civilian microchips sourced from home appliances and commercial products in military systems, the extent of this cannibalization process remains difficult to assess.[111]

Repurposed civilian microchips typically include simple microcontrollers, rather than more complex components such as navigation modules and microcomputers, with the latter often obtained from Western companies through sanction-evading schemes. In this respect, Russia has managed to partially offset Western export restrictions and retain access to high-end parts for its drone and missile capabilities, while also benefiting from Chinese alternatives.

Chapter 2 — Key military capabilities and hardware

The impact of the war and sanctions on military-grade components and raw materials implies that the production of finished systems is also affected across key military domains. Output constraints and industrial bottlenecks must also be assessed in critical areas paramount to supporting the war effort: armored land platforms, artillery shells, military aviation, missile systems, and drones.[112]

This is compounded by ground equipment losses in Ukraine since 2022, effective Ukrainian countermeasures against Russian air platforms and strikes, and high rates of fire for artillery shells and conventional warheads.

2.1 Armored vehicles

The full-scale invasion of Ukraine has put immense stress on the stockpile and production of main battle tanks (MBTs), infantry fighting vehicles (IFVs), and armored personnel carriers (APCs). One of the most acute vulnerabilities for Russia has been the unprecedented attrition of its armored vehicle fleet amid the vast use of anti-tank mines and anti-tank weapons and the proliferation of tactical attack drones. This has been compounded by challenges in producing enough new platforms to replenish battlefield losses and sustain the long-term armed forces' restructuring and expansion pursued by the Russian Ministry of Defense (MoD).[113]

In response, Russian forces have pursued two main adaptation strategies. First, they have tapped into their vast stocks of Soviet-era military equipment. During 2023, for example, approximately 1,500 tanks were delivered to Russian forces, with open-source analyses suggesting about 86% of these were refurbished decades-old models, such as T-62s and even T-55s.[114]

Second, they have shifted to infantry-centric assaults revolving around small units and infiltration tactics mainly supported by UAVs and glide bombs, while progressively reducing the intensity of mechanized assaults by 2024, and replacing most (though not all) armored vehicles (especially tanks and armored fighting vehicles, or AFVs) with civilian alternatives such as Soviet UAZ-452 vans, quad bikes, and even electric scooters.[115] While sporadic mechanized attacks still occur, armored vehicles are now primarily employed in support roles (e.g., to provide indirect fire) to minimize their exposure to Ukrainian drones, and the number of documented Russian AFV losses has decreased significantly over the past year.[116]

Several open-source analyses have done a remarkable job shedding light on the extent of Russia's vehicle refurbishment and production endeavor, though their

estimates — which this paper also integrates — are based on fragmentary and incomplete evidence and should not be treated as conclusive. Older tanks, including T-62s, T-72s, and T-80s, are being withdrawn from deep storage, refurbished, and upgraded to replenish significant battlefield losses. For instance, the 103rd Armored Repair Plant (BTRZ) has focused on the modernization of T-62s, with an estimated refurbishment rate of 300 to 500 units annually.[117]

Similarly, Omsktransmash has extensively overhauled and modernized T-80 tanks, exhausting most stored hulls, with an assessed rate of over 300 units per year.[118] In addition, T-72As, BKs (command version of the T-72), and other old variants — which represent the most abundant tank stock Russia has left — are converted into T-72B3M at Uralvagonzavod (UVZ) and a handful of smaller BTRZ centers, with the overall output estimated at around 30 tanks per month, as of 2025.[119]

The overhaul of old infantry fighting vehicles (IFVs) — mainly BMP-1/2s — has expanded as well. Currently, the biggest efforts are led by the companies Kurganmashzavod and Rubtsovky, along with the 163rd Armored Repair Plant in Krasnodar Krai, with a combined output assessed between 450 and 600 units in 2025.[120] Other plants such as the 81st BTRZ at Armavir are estimated to overhaul and modernize up to 200 BTR-70/80/82s per year since 2023.[121]

Various contracts for the restoration or resumed production of large batches of engines such as the V-84 (used for the T-72 and T-90), GTD-1250 (for the T-80 family), and UTD-20 (for BMP-1s) were signed between 2023 and 2024 to support this effort.[122] At the same time, Russian refurbishment specialists have also devised creative solutions, including the conversion of older T-72 and T-90 tanks' chassis into tank support combat vehicles (BMPT).[123]

As for MT-LB light tracked armored tractors, a significant portion of reserves (around 3,500 pieces) were pulled and rapidly sent to Ukraine to replenish losses, with an estimated yearly refurbishment rate of 100 units mainly at the Muromteplovoz Zavod plant in the Vladimir region.[124] Estimates on the remaining amount of MT-LBs in storage vary between 1,200 and 600 units, a significant portion of which are likely in suboptimal conditions.[125]

Overall, based on publicly available data and open-source intelligence (OSINT) analyses, Russia has pulled from storage a massive amount of older armored vehicles, estimated at nearly 15,000 units, including tanks, BMP-1 and 2 IFVs, BTRs armored personnel carriers (APCs), and MT-LBs, and has likely between 7,500 and 8,200 units still in reserve, of which only about 4,790 (63% to 58%) are deemed to be refurbishable.[126]

In parallel with refurbishment, Russia has taken steps to ramp up the production of new armored vehicles. Uralvagonzavod, the sole plant manufacturing tanks from scratch, is producing T-90M main battle tanks, with production estimates ranging from 250 to 300 units annually by 2024.[127] Leaked state contract documents obtained by the Ukrainian Frontelligence private analytics firm indicate an ambitious plan to expand T-90M production by 80%, including the launch of a new variant, the T-90M2, by 2028.[128] As a result, Russia plans to manufacture 765 new T-90M variants between 2027 and 2029, to which must be added 347 T-90Ms obtained through capital overhaul and modernization, for a total of almost 1,120 T-90M/M2 platforms in three years.[129]

When it comes to newly produced vehicles other than MBTs (chiefly IFVs and APCs), Kurganmashzavod appears to be the most active OPK, having built around 360 new BMP-3 infantry fighting vehicles in 2024 and increased that output to likely 400 to 480 units in 2025, along with 80 to 120 BMD-4M in the same period.[130]

However, in the available financial reports of Kurganmashzavod, monetary inflation and cost-plus inflation betray that such a high level of production rate growth is unlikely, especially when compared to the known 100 to 120 BMP-3 and 60 to 70 BMD-4M produced in 2021.[131]

Actual production rates of BMP-3 may be assessed at 250 to 320 units a year, and the actual production rates of BMD-4M can hardly exceed 120 units a year.

Table 3: Annual financial results of Kurganmashzavod, 2021-25

Category	2021	2022	2023	2024	2025
Total revenue	$349,100,000	$552,400,000	$629,800,000	$836,800,000	$1,206,900,000
Incl. revenue from supplies of products	$343,300,000	$495,200,000	$506,700,000	$668,000,000	N/A
Net-profit	$7,000,000	$19,900,000	$12,800,000	$25,700,000	$41,500,000
Total revenue (prices of 2021)	$349,100,000	$511,500,000	$560,000,000	$722,800,000	$1,015,800,000
Incl. revenue from supplies of products (prices of 2021)	$343,300,000	$458,500,000	$450,600,000	$577,000,000	N/A
Net-profit (prices of 2021)	$7,000,000	$18,400,000	$11,400,000	$22,200,000	$34,900,000

Figures as calculated directly from source.
Table: Peter Roberto/Center for European Policy Analysis • Source: JSC Kurganmashzavod

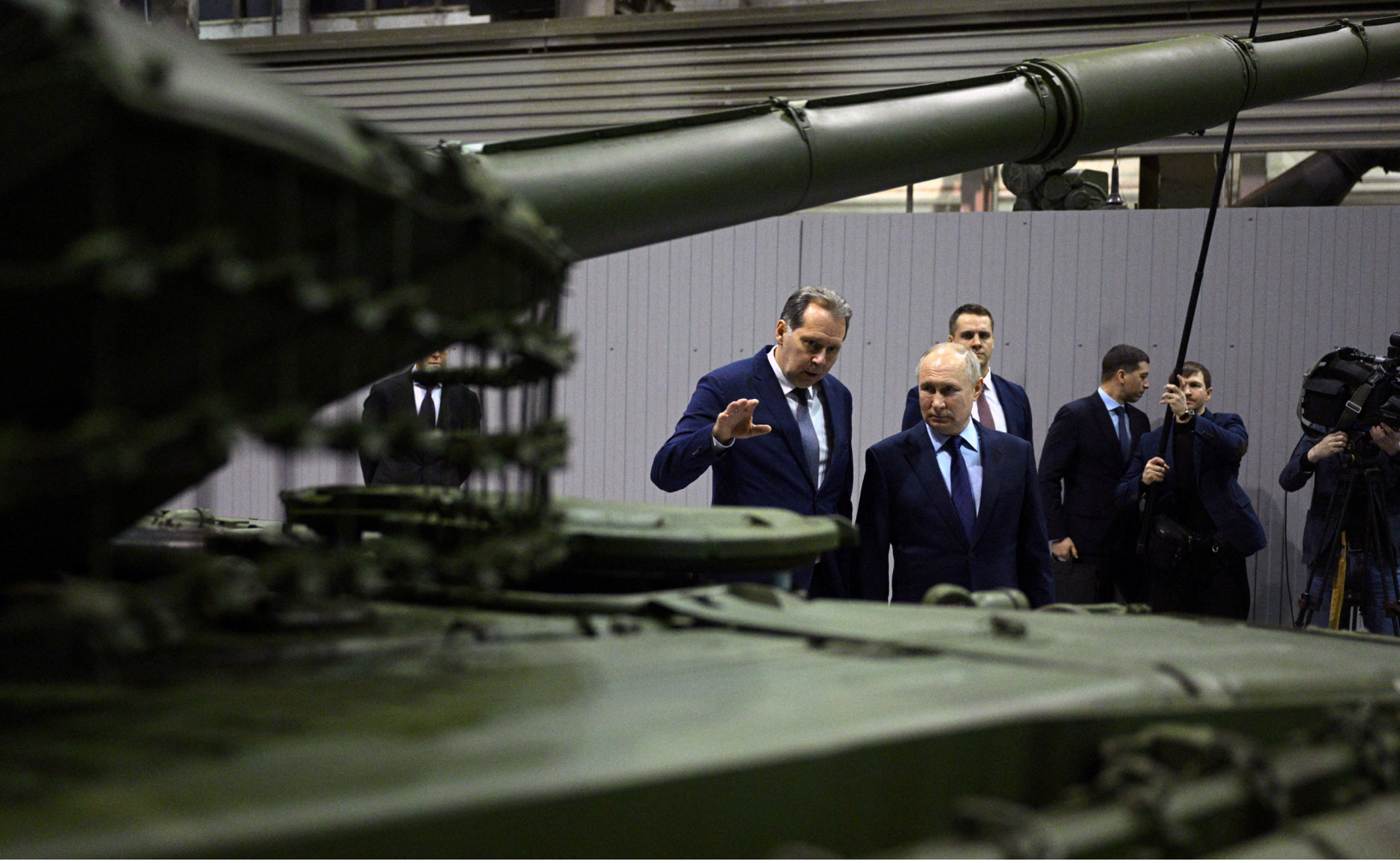


Image: Russia's President Vladimir Putin listens to the company's CEO Alexander Potapov as he visits a military plant of Uralvagonzavod research and production corporation in the Urals city of Nizhny Tagil, Russia, February 15, 2024. Credit: Sputnik/Ramil Sitdikov/Pool via REUTERS.

The other vehicle built from scratch in large numbers is the BTR-82, manufactured by Arzamas and a staple in Russia's armored vehicle fleet, with most estimates nearing 500 to 600 units per year.[132] This means around 1,000 new IFVs and APCs were built in 2025.

Based on the above figures, it seems safe to estimate the combined production and refurbishment of various armored fighting vehicles of 2025, including tanks and other fighting vehicles (but excluding artillery), at approximately 3,700 units, although only one-third of these are new builds.[133] While in 2022 Russia possessed vast stocks of stored vehicles, observers suggest a large chunk of the remaining reserves have minimal availability rates and are suitable only for cannibalization of parts rather than for front-line use.[134] Open-source analyses based on satellite imagery, for example, indicate that as of 2024, up to 40% of strategic tank reserves had already been withdrawn from open-air storage since 2022.[135] A similar trend of rapid withdrawal has been observed with other armored vehicles.[136]

Overall, we estimate that this significant running-down of reserves — chiefly MBTs — has forced Russia increasingly toward building newer hardware from scratch as early as 2025 and even more so by 2026–2027, with older vehicles typically sent to Ukraine. While this practice will eventually result in a more modern fleet composition, it also means that, unless new production increases significantly, Russia's ability to replenish losses and generate sufficient armored capabilities in case of renewed large-scale offensive operations in Ukraine will rapidly decline due to the poor quality of its thinning Soviet-era stocks.

However, we also assess that the combination of tapping into legacy stockpiles, expanding new production, and reducing mechanized assaults has contributed to restoring Russia's AFV operational fleet to pre-2022 levels, if not greater ones, though at the cost of quality. Efforts are underway to implement key lessons from Ukraine, including equipping key platforms such as MBTs with novel active anti-drone protection systems to increase survivability.[137] In addition, OPKs have not abandoned major land vehicle programs such as the Kurganets-25 and Manul IFVs, although their future realization is far from certain.[138]

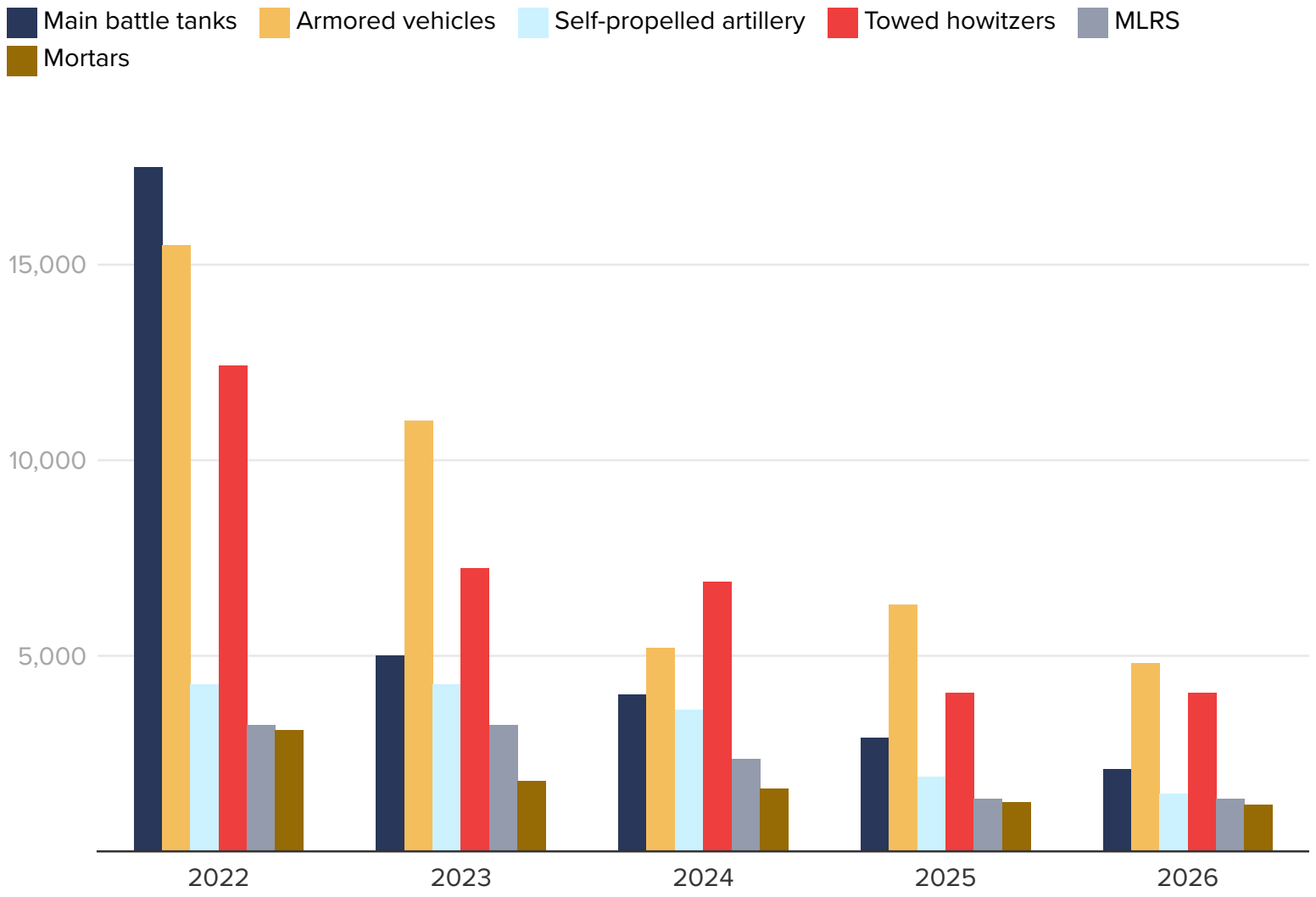
Considering battlefield losses, with more than 13,500 armored vehicles visually confirmed as destroyed since 2022,[139] Russia will ultimately have to make a trade-off between reducing the pace of high-intensity operations or risking burning through the majority of its strategic reserves, while the production of new units sees only modest growth.

Looking ahead, Moscow may decide to further curtail its use of tanks as existing stocks near depletion, prioritizing increased production of new T-90s to either sustain the current operational use or rebuild its armored forces. At the current pace of MRO and production, estimates converge on 2026 as the year when Moscow will have sacrificed more units in Ukraine than it has available in storage.[140]

Still, as current infantry tactics yield little progress against Ukrainian defenses, we do not exclude the resumption of focused mechanized attacks whereby tank and AFV units held in reserve are employed against less defended sectors of the Ukrainian front to attempt rapid penetration and exploitation. In a recent large-scale attack in the Lyman direction, for instance, Russian forces deployed tens of armored vehicles, including BMP-3, BTR-82s, and tanks, but failed in breaking through Ukrainian defenses and were decimated.[141]

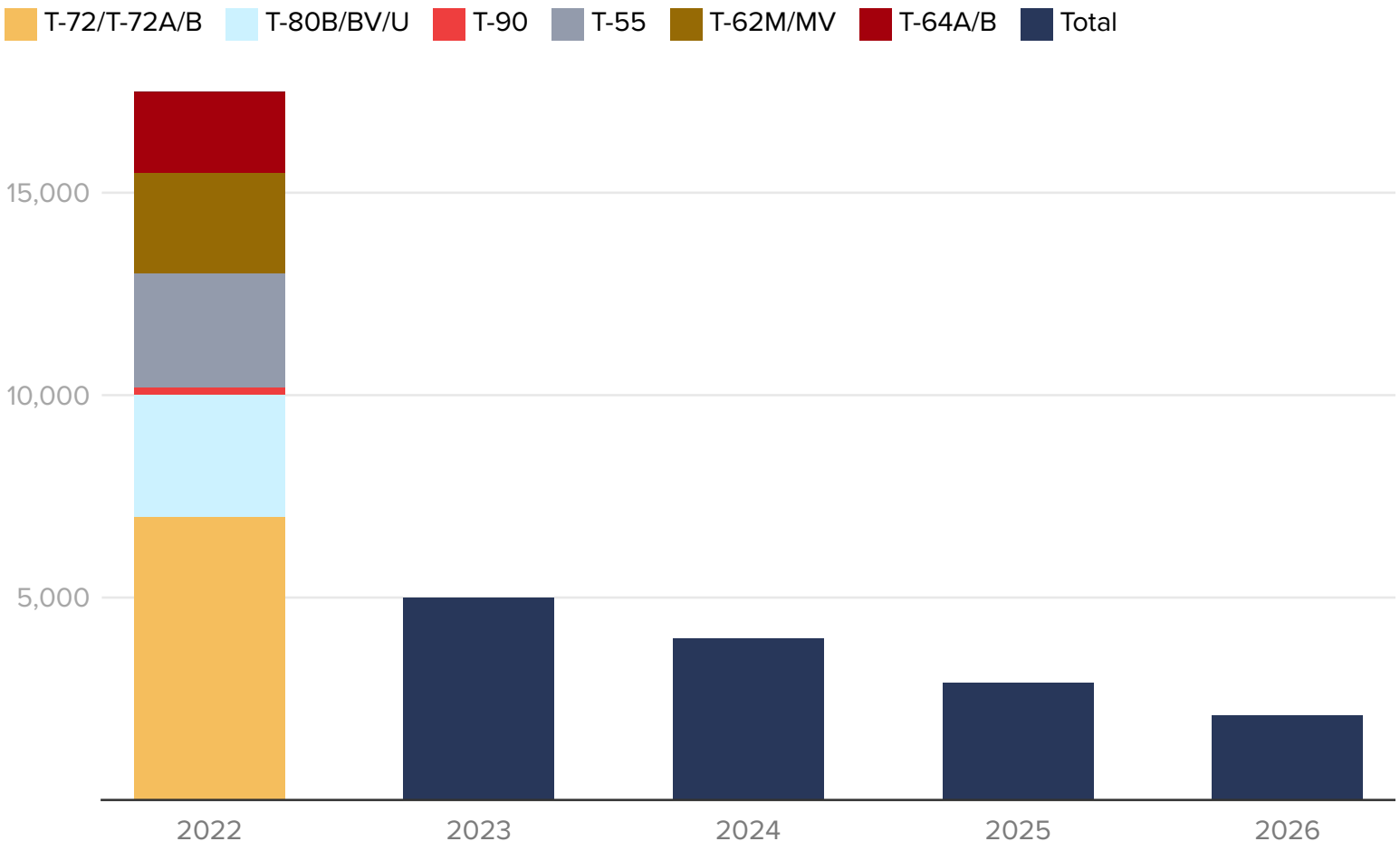
The overall conservative assessment of stockpiles of conventional arms by 2026 made by the International Institute for Strategic Studies (IISS) is the following.

Figure 7: Russian Conventional Arms on Storage Bases



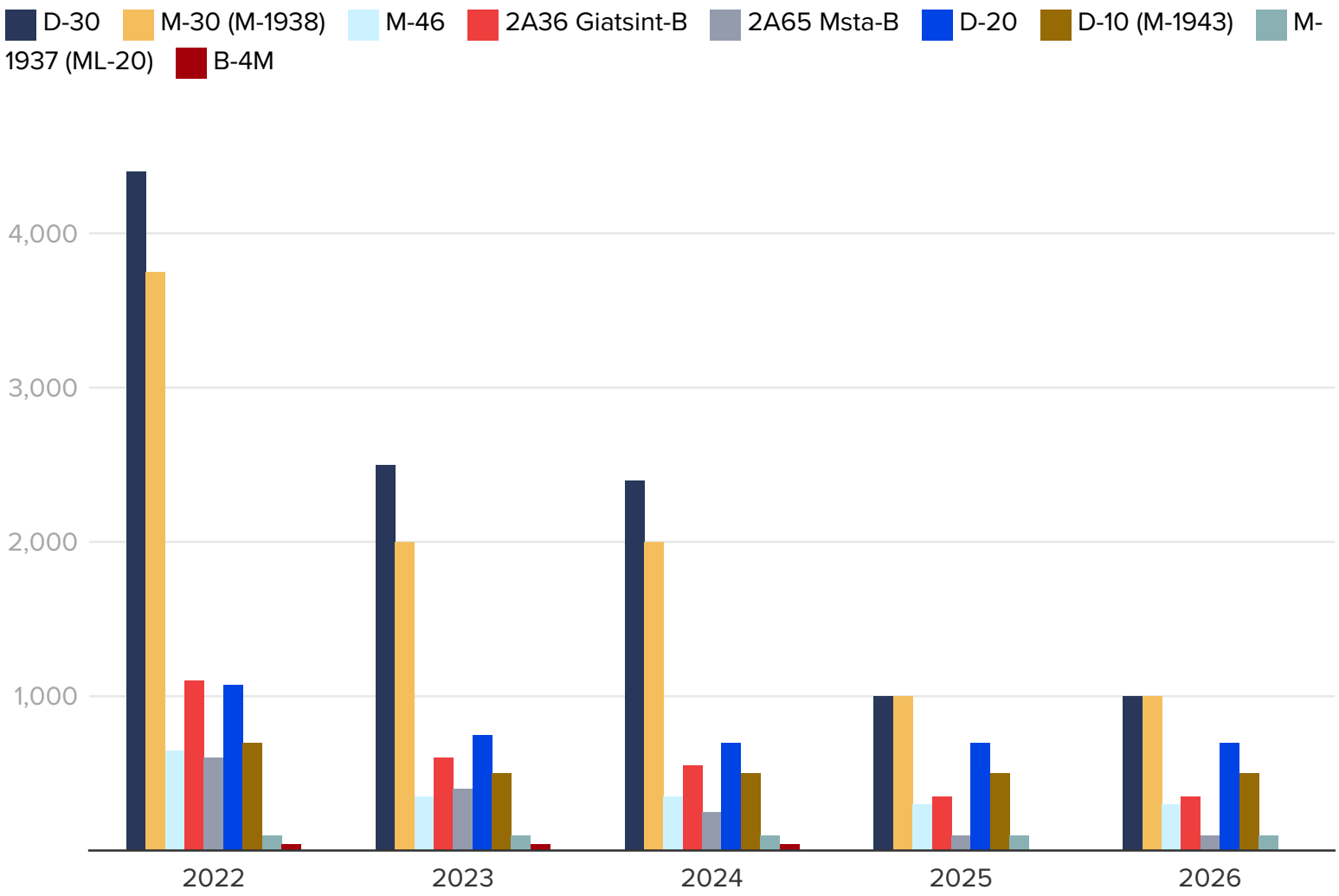
Source: The Military Balance 2022 (IISS, 2022), https://www.iiss.org/publications/the-military-balance/the-military-balance-2022/; The Military Balance 2023, (IISS, 2023), https://www.iiss.org/publications/the-military-balance/the-military-balance-2023/; The Military Balance 2024, (IISS, 2024), https://www.iiss.org/publications/the-military-balance/2024/the-militarybalance-2024/; The Military Balance 2025 (IISS, 2025), https://www.iiss.org/publications/the-military-balance/2025/themilitary-balance-2025/; The Military Balance 2026, (IISS, 2026), https://www.iiss.org/publications/the-militarybalance/2026/the-military-balance-2026/.

Figure 8: Russian Main Battle Tanks in Storage Bases



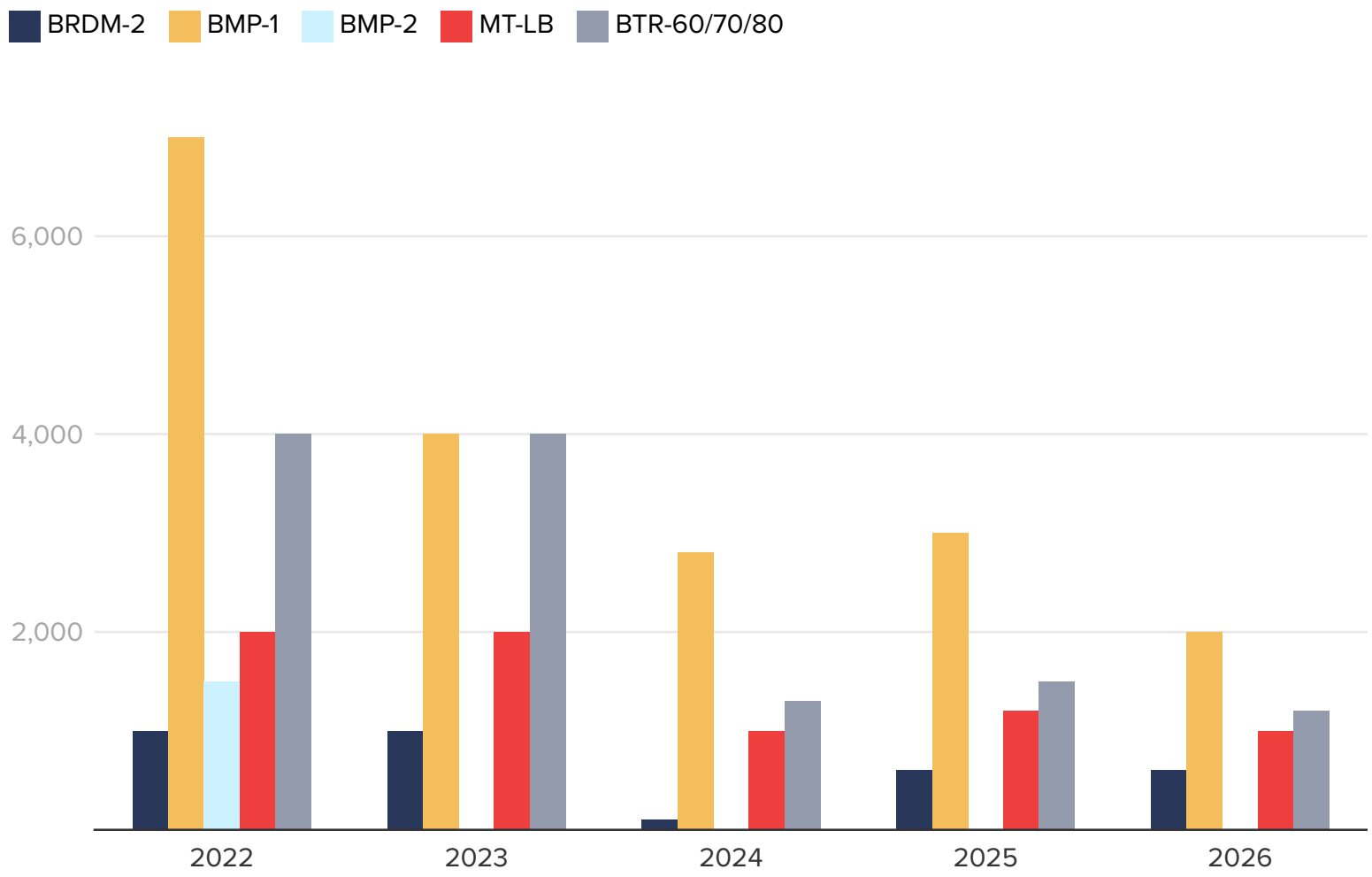
Based on available data
Source: The Military Balance 2022 (IISS, 2022), https://www.iiss.org/publications/the-military-balance/the-military-balance-2022/; The Military Balance 2023, (IISS, 2023), https://www.iiss.org/publications/the-military-balance/the-military-balance-2023/; The Military Balance 2024, (IISS, 2024), https://www.iiss.org/publications/the-military-balance/2024/the-militarybalance-2024/; The Military Balance 2025 (IISS, 2025), https://www.iiss.org/publications/the-military-balance/2025/themilitary-balance-2025/; The Military Balance 2026, (IISS, 2026), https://www.iiss.org/publications/the-militarybalance/2026/the-military-balance-2026/.

Figure 9: Russian Towed Howitzers in Storage Bases



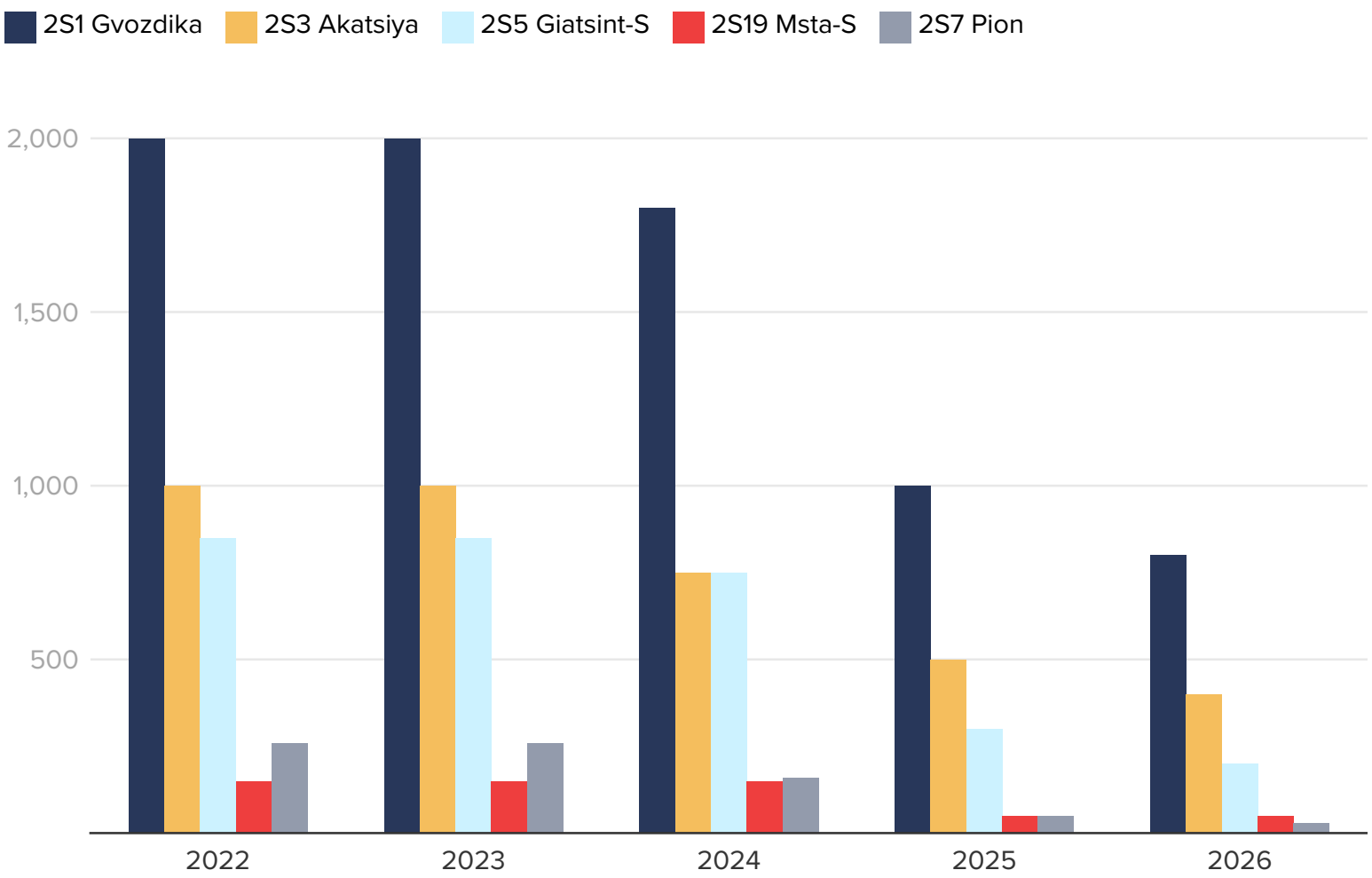
Source: The Military Balance 2022 (IISS, 2022), https://www.iiss.org/publications/the-military-balance/the-military-balance-2022/; The Military Balance 2023, (IISS, 2023), https://www.iiss.org/publications/the-military-balance/the-military-balance-2023/; The Military Balance 2024, (IISS, 2024), https://www.iiss.org/publications/the-military-balance/2024/the-militarybalance-2024/; The Military Balance 2025 (IISS, 2025), https://www.iiss.org/publications/the-military-balance/2025/themilitary-balance-2025/; The Military Balance 2026, (IISS, 2026), https://www.iiss.org/publications/the-militarybalance/2026/the-military-balance-2026/.

Figure 10: Russian Armored Vehicles in Storage Bases



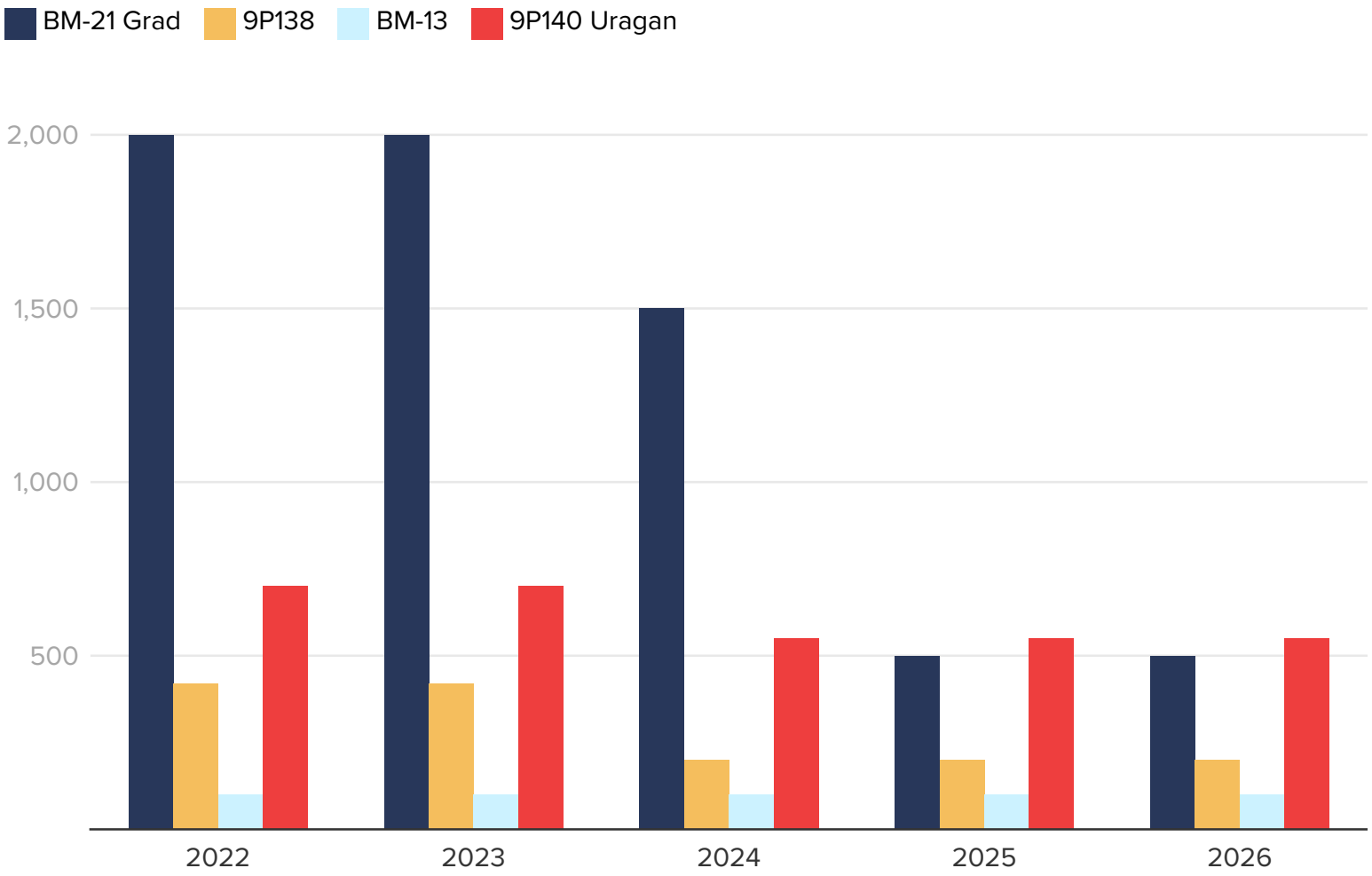
Source: The Military Balance 2022 (IISS, 2022), https://www.iiss.org/publications/the-military-balance/the-military-balance-2022/; The Military Balance 2023, (IISS, 2023), https://www.iiss.org/publications/the-military-balance/the-military-balance-2023/; The Military Balance 2024, (IISS, 2024), https://www.iiss.org/publications/the-military-balance/2024/the-militarybalance-2024/; The Military Balance 2025 (IISS, 2025), https://www.iiss.org/publications/the-military-balance/2025/themilitary-balance-2025/; The Military Balance 2026, (IISS, 2026), https://www.iiss.org/publications/the-militarybalance/2026/the-military-balance-2026/.

Figure 11: Russian Self-Propelled Artillery on Storage Bases



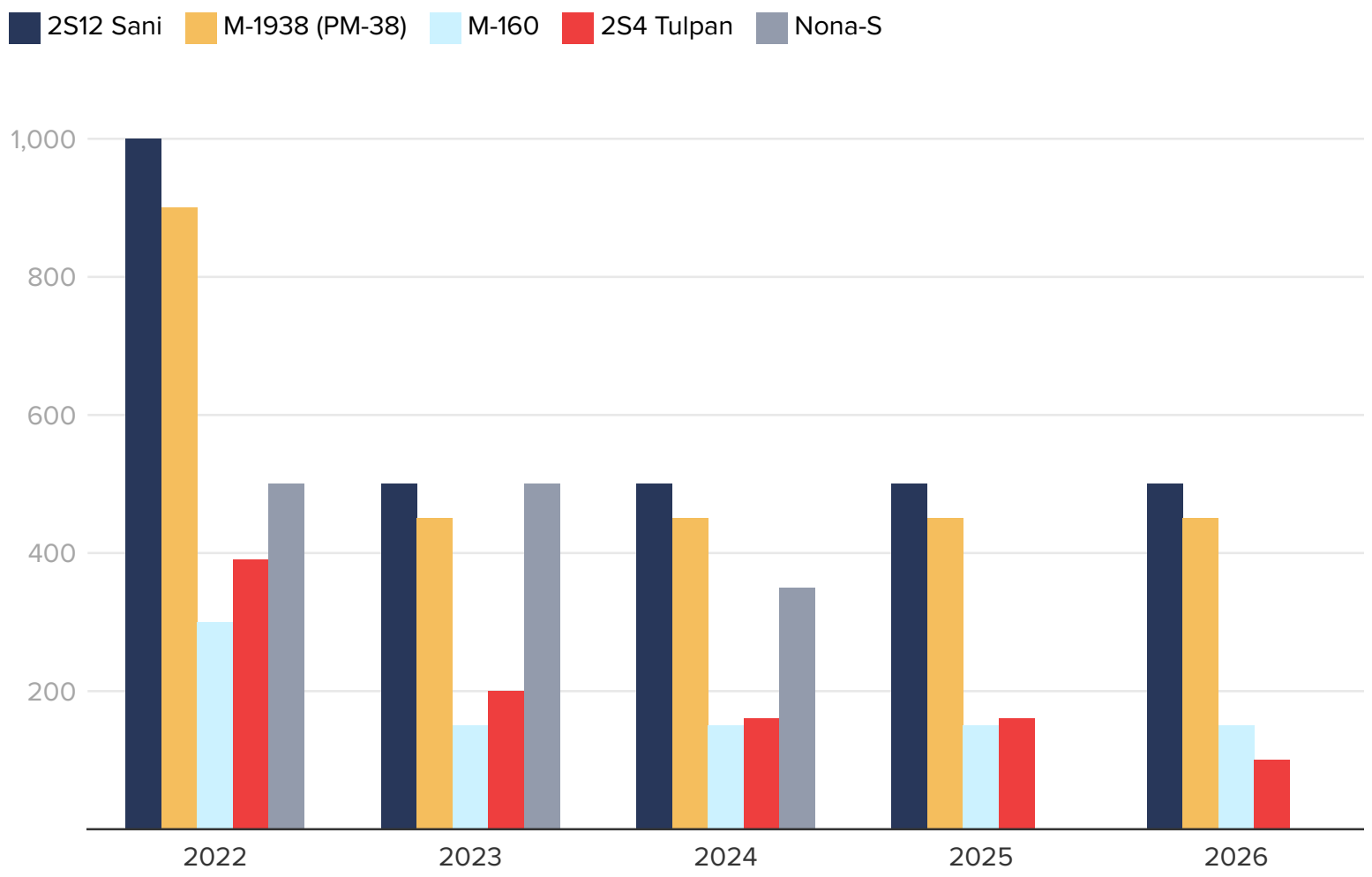
Source: The Military Balance 2022 (IISS, 2022), https://www.iiss.org/publications/the-military-balance/the-military-balance-2022/; The Military Balance 2023, (IISS, 2023), https://www.iiss.org/publications/the-military-balance/the-military-balance-2023/; The Military Balance 2024, (IISS, 2024), https://www.iiss.org/publications/the-military-balance/2024/the-militarybalance-2024/; The Military Balance 2025 (IISS, 2025), https://www.iiss.org/publications/the-military-balance/2025/themilitary-balance-2025/; The Military Balance 2026, (IISS, 2026), https://www.iiss.org/publications/the-militarybalance/2026/the-military-balance-2026/.

Figure 12: Russian MLRS on Storage Bases



Source: The Military Balance 2022 (IISS, 2022), https://www.iiss.org/publications/the-military-balance/the-military-balance-2022/; The Military Balance 2023, (IISS, 2023), https://www.iiss.org/publications/the-military-balance/the-military-balance-2023/; The Military Balance 2024, (IISS, 2024), https://www.iiss.org/publications/the-military-balance/2024/the-militarybalance-2024/; The Military Balance 2025 (IISS, 2025), https://www.iiss.org/publications/the-military-balance/2025/themilitary-balance-2025/; The Military Balance 2026, (IISS, 2026), https://www.iiss.org/publications/the-militarybalance/2026/the-military-balance-2026/.

Figure 13: Russian Mortars on Storage Bases



Source: The Military Balance 2022 (IISS, 2022), https://www.iiss.org/publications/the-military-balance/the-military-balance-2022/; The Military Balance 2023, (IISS, 2023), https://www.iiss.org/publications/the-military-balance/the-military-balance-2023/; The Military Balance 2024, (IISS, 2024), https://www.iiss.org/publications/the-military-balance/2024/the-militarybalance-2024/; The Military Balance 2025 (IISS, 2025), https://www.iiss.org/publications/the-military-balance/2025/themilitary-balance-2025/; The Military Balance 2026, (IISS, 2026), https://www.iiss.org/publications/the-militarybalance/2026/the-military-balance-2026/.

Nevertheless, the absolute majority of the arms remaining on the storage bases can hardly be revived and used.[142]

2.2 Artillery systems

Russia's approach to artillery fire during the full-scale invasion is showing its limits: limited range, lack of precision, reliance on saturation fires, and an inability to adequately suppress Ukrainian drone capabilities and artillery counterpart. The situation is causing natural battlefield attrition, not least because Russian artillery cannot get in range to affect Ukrainian targets without risking destruction. Suppression comes at the cost of saturation. From an OPK perspective, this means that more rounds, more tube artillery systems (self-propelled and towed), and more rocket artillery must be produced at increasingly higher rates to sustain the war effort.

As in other industrial segments, Moscow drew on the Soviet-inherited stockpile of artillery systems and munitions stored throughout the country during the initial phase of the full-scale invasion. Existing reserves, however, "were not dimensioned to take on a major, high-intensity and protracted war."[143] Estimates vary, but less than 40% of Russia's stockpile of artillery systems would now remain in storage, with some figures indicating that fewer than 20% of multiple rocket launch systems (MRLS) remain available.[144]

Domestic production of artillery systems has been increasing at unprecedented rates each year since 2022. Production of all types of artillery shells increased by about 10% between 2024 and 2025, reaching 1.717m units.[145] The production of mortar rounds reportedly grew by almost 40% over the same period. However, constant output growth comes at the cost of overstretched production chains.[146] If shells and rocket artillery can be produced in large quantities for the foreseeable future, a bottleneck has emerged in the production of tube artillery systems (not least the barrels themselves, which need regular replacement to avoid losing range and accuracy).[147]

However, the recent leak demonstrates the much higher numbers of artillery shells supplied to the Russian armed forces in 2025:[148]

- 750,000 82 mm artillery shells
- 1,900,000 120 mm artillery shells
- 850,000 122 mm shells
- 1,700,000 152 mm shells
- 60,000 203 mm shells
- 20,000 240 mm artillery shells

This totals some 5.3m artillery shells. The discrepancy between domestic output of gunpowder and explosives and the numbers of supplied artillery shells likely comes from North Korean supplies. Considering the total assessment of artillery shells imported from North Korea in 2023–2025 as 8m to 11m,[149] it is possible that there were 3.5m to 3.6m artillery shells supplied by North Korea only in 2025. Probably, some of the imported and domestically manufactured artillery shells were also stockpiled.

Consequently, if the supplies from the DPRK decrease because its stockpiles are also not endless, Moscow would start to suffer from "shell hunger," as ammunition production is "hand-to-mouth."[150] In other words, "Russians are still using artillery at faster rates than they can replenish it."[151] As fire rates continue to decrease, Russia will have to carefully balance saturation and gradual exhaustion. This statement is true only if Moscow continues to prosecute the war at the same rate of fire of 10,000 rounds per day/300,000 per month. To achieve genuine territorial gains, the OPK would need to produce more rounds than it can currently achieve.

However, there was also an alternative assessment made by the Center for Strategic and International Studies (CSIS) in early 2024 when the projected production rates for that year were 4m 152 mm and 1.6m 122 mm artillery shells.[152] In any case, this amount of domestic output was hardly possible considering the known production rates of key chemical components presented above in this report. The possible explanation is that Russia tries to camouflage supplies from North Korea by presenting the imported artillery shells as domestically made.

Even increased domestic output will not allow Russia to make massive territorial gains in Ukraine without sacrificing both the remaining strategic reserves and OPK production chains. Meanwhile, North Korean artillery systems and munitions offer an adequate solution to Russia's growing shell shortage,[153] although it comes with political constraints and risks linked to sanctions evasion schemes. The only internal solution for Moscow is to open more production lines in the coming months. Even then, the availability of more rounds would likely prompt the Russian leadership to overuse them.

2.3 Military aviation

Despite its operational setbacks and significant losses in Ukraine, the air force remains a critical element of Russia's conventional power. For this reason, in 2025, Russia's military aircraft industry focused on sustaining and expanding the output of its key platforms, notably the Su-35S, Su-34M, and Su-57 fighters, amid considerable external and internal pressures. The United Aircraft Corporation (UAC), which consolidates major design bureaus such as Sukhoi and manufacturing sites like Komsomolsk-on-Amur, Novosibirsk, and Irkutsk, is the primary contractor of these military aircraft.

Official and expert sources estimated that Russia delivered between 15 and 20 Su-35S fighters to the Russian Aerospace Forces (VKS) in 2025, with production occurring at the Komsomolsk-on-Amur Aircraft Plant. Deliveries were documented in seven batches throughout the year, a consistent output that slightly exceeded the previous year's total.[154]

Similarly, manufacturing of the Su-34 at the Chkalov Aviation Plant in Novosibirsk has increased, with around 18 to 20 units delivered in 2025, according to open sources, marking a notable rise from earlier years and highlighting the prioritization of the Su-34M for the VKS's capabilities.[155]

It is worth noting that Russia has also major combat aircraft export contracts in place, including with Algeria for the Su-34ME, Su-35S, and Su-57E; Belarus for the Su-30SM2; and Iran for the Su-35 fighter and Mi-28NE helicopter. Public information indicates that the Russian industry appears able to fulfill these orders, hinting at an overall resilient production capacity despite supply chain challenges and international sanctions.[156]

As for Russia's most modern combat aircraft, the Su-57, production at the Komsomolsk-on-Amur facility seems to proceed at a sustained pace after repeated delays, with a more consistent output since 2023. While only two aircraft were reportedly delivered in 2025, in February of this year Rostec announced the delivery of "a large batch" of Su-57s in "a new technical configuration," which likely explains the slight delay of the transfer.[157]

Given that, as of early 2025, the VKS had reportedly received 34 aircraft, the current size of the Su-57 fleet is likely approaching the 50 mark if we consider the previous two years' production, both in excess of 10 airframes.[158] The MoD official contract expects the transfer of 76 platforms by 2027, but progress remains vulnerable to component shortages and supply chain disruptions, and it is unclear whether this timeline will be met.[159] Still, a recent Ukrainian drone strike may have disrupted the work at the facility.[160]

Russia also delivered seven units of the Il-76MD-90A military transport aircraft in 2025, manufactured by the Ilyushin Aircraft Company at Aviastar-SP in Ulyanovsk, marking a steady increase in military transport aircraft output since 2023.[161] Russian sources anticipate a further expansion of this production line in the coming years.[162] However, Ukrainian drones struck the Aviastar-SP plant on March 16, claiming varying degrees of damage to an aircraft hangar and multiple aircraft parked nearby.[163]

Conversely, the production of larger and more complex platforms such as the Tu-160M strategic missile carrier has encountered major delays, although it has not entirely stopped. In December 2025, Belousov announced that the VKS had received two new Tu-160Ms, though he did not provide any further details on

whether these were produced from scratch or modernized from older Tu-160s.[164] The latter is likely.

The Kazan Aviation Plant — a Tupolev subsidiary and the sole manufacturer of the Tu-160, along with civilian passenger planes — underwent significant construction and expansion work in 2024, visible in open-access satellite imagery, indicating the company's commitment to ramp up production.[165] However, this effort seems to be mired in structural problems, including the lack of skilled labor, supply chain disruptions, and certification delays.[166]

Overall, 2025 can be touted as a record year for Russian military aircraft production compared to the previous ones, with estimates placing the total number of fighter aircraft delivered domestically at 33 and up to 55 units when exports are included.[167]

2.4 Missile systems

"As for the production of the corresponding missile systems and related equipment, Russia's output is 10 times greater than the combined output of all NATO countries combined. Next year, this production will increase by another 25-30%."[168]

Vladimir Putin
Speech on the occasion of the 2024 CSTO Summit, November 2024

Four years into the full-scale invasion of Ukraine, the armed forces continue to use tactical and long-range precision strike missiles to prosecute the war. This includes cruise, ballistic, and air-launched missiles used in a variety of missions. Like artillery shells, missile production is "hand-to-mouth" in Russia, balancing domestic production with immediate battlefield use.

Russia's missile production has demonstrated a striking degree of expansion and resilience in the face of international sanctions, underpinned by state-driven mobilization, adaptive supply chain practices, and extensive efforts at circumventing Western export controls. This is the case for Russia's entire missile inventory, reflecting a concerted effort by the Kremlin and the Ministry of Defense to bolster the country's standoff strike capabilities.

Missile production

According to a Ukrainian military analyst, Russia is now able to replenish its missile arsenal at roughly 120 to 150% of its expenditure rate, with peaks of 160% and even 200% for the Iskander family and Kh-59/Kh-69 families of missiles, respectively.[169] Production of the X-101/Kh-101 air-launched cruise missile — the cornerstone of Russia's deep strike arsenal — has accelerated sharply, moving from 56 units per

year in 2021 to approximately 50 to 70 per month by 2024, with an estimated output of 633 missiles throughout 2025 and an additional 233 already on contract for 2026, according to leaked documents from the manufacturer examined by a Ukrainian private intelligence firm.[170]

Notably, in 2023, engineers at the Tactical Missile Corporation upgraded the system with the digital scene matching area correlator (DSMAC) optoelectronic guidance suite "Otblesk-U" (Отблеск-U) for better accuracy, along with releasable radio decoys and flares to evade Ukrainian interceptors.[171]

The Iskander-M (9M723) ballistic missile — which is manufactured by the Russian Machine-Building Design Bureau and has proven particularly effective at prosecuting high-value targets across Ukraine's operational depth — has seen monthly output double from approximately 40 units in early 2024 to as many as 70 in mid-2025, with estimates placing the stockpile at close to 500–600 units in the same period.[172]

However, the current monthly output is likely higher, at around 80 missiles, by which Russian forces can continue to sustain moderate to high weekly use while simultaneously building up strategic supplies over time. China's material support has been instrumental in ramping up this system's production, especially through the provision of up to 70% of Russia's total imports of sodium chlorate, a key ingredient for the production of the Iskander-M's solid propellant.[173] Production of the 9M728/9M729 Iskander-K cruise variant has also increased to 20 to 30 units per month, with a reported stock of 300 units in mid-2025.[174]

Additional key systems include the Kalibr (3M-14) sea-launched cruise missile, manufactured at the Novator Design Bureau in Yekaterinburg at about 300 to 350 units annually; the Kinzhal (Kh-47M2) hypersonic missile, an air-launched derivative of the Iskander-M system, with 44 produced in 2024 and up to 15 monthly as of June 2025; and the 3M55 Onyx and 3M22 Zircon anti-ship missiles, produced by the NPO Mashinostroyeniya Military Industrial Corporation.[175] The latter's monthly production rate as of mid-2025 was between 20 and 30 units, according to Ukrainian intelligence.[176]

Current production also comprises the Kh-59/Kh-69 cruise missiles, though repeated Ukrainian strikes and lack of components have severely disrupted the manufacturing process, forcing companies to install older R95 engines and even mockup guidance sections.[177] Ukrainian intelligence assesses that almost 120 enterprises are involved in the Kh-59's production, of which 40% remain unsanctioned. Still, the contractor was unable to fulfill the Ministry of Defense's order as of mid-2025.[178]

In 2025, Russia launched 1,952 missiles of various types against Ukraine, based on Ukrainian Air Force statistics.[179] Considering the abovementioned production figures,

current Russian missile stocks are likely in the range of 2,000 units, thus allowing Russia to sustain more frequent and large missile barrages.[180] Besides increasing its domestic missile output, between 2023 and mid-2025 Russia imported likely more than 200 North Korean KN-23/KN-24 short-range ballistic missiles, which have supplemented Russian arsenals and provided munition flexibility to Russian weaponeers.[181]

It is worth noting that quality control and reliability have become major issues due to both the shortage of high-quality Western-made components and the use of lower-quality alternatives. Still, companies typically prioritize fulfilling their contractual obligations on time, regardless of the higher risk of system malfunction.[182] As a result, the likelihood of system failures may rise proportionally with the expanding production and increase the chances of incidents within Russian territory. Despite a few such cases, it is unlikely that this problem will result in political consequences for local or federal authorities.[183] A higher failure risk could diminish the penetration rate of Russian missile salvos and erode one of Moscow's main military advantages.

Against the backdrop of expanding production, dependency on foreign components is strong in the missile segment. Most missile platforms used by Russia remain highly reliant on foreign-made high-technology subsystems. Attempts at import substitution for missiles have seen minimal results beyond lower-complexity systems, and continued dependence on foreign microchips, especially in guidance and control, remains a technical vulnerability.[184] Moreover, repeated logistical bottlenecks, such as those arising in altimeter production, imply that even a single supply-chain interruption can jeopardize output across multiple missile types.[185]

As a result, to meet urgent state defense orders (GOZ), Russian manufacturers accept the risks of mixing untested new and old stock, occasionally at the expense of system quality and reliability.[186] More frequent Ukrainian strikes, including the successful destruction of the Kremniy El microelectronics facility in Bryansk on March 10, compound these challenges.[187]

Structural dependency is evident even in one of Russia's most recent missile systems: the Izdelie-30 cruise missile, designed and manufactured by the Tactical Missile Corporation (JSC). An analysis of its categorized components and subcomponents (43) reveals that only 15 (34%) come from Russia, with 10 (23%) manufactured by US companies — including Analog Devices and Ingenic Semiconductor — three (7%) by Swiss firms, another 7% manufactured by Chinese, Belarusian, and Dutch enterprises, and the remaining 28% still of unknown origin.[188]

The UMPK module: more bang for Russia's buck

In terms of battlefield adaptations, Russia's mass use of UMPK glide and guidance modules stands out as one of the most consequential. This cheap module is manufactured by the Tactical Missiles Corporation JSC (KTRV) — an industrial conglomerate that includes multiple subsidiaries — and, since 2023, has allowed Russia to retrofit tens of thousands of general-purpose bombs, typically Soviet-era FAB-250 and -500 types but also the heavier FAB-1500 and -3000, thus compensating for the serious ammunition shortage that beleaguered the Russian artillery in 2023 and 2024.

They are typically launched by Su-34 multirole bombers from standoff ranges, outside the envelope of Ukrainian air defenses, and deliver powerful high-explosive effects with decent accuracy that often result in the obliteration of entire buildings and strongholds.[189]

These weapons were instrumental in ousting Ukrainian forces from Avdiivka in early 2024, with 150 to 200 strikes per day during the offensive's peak.[190] Hundreds of glide bomb strikes continue to occur daily, and Russia has begun to employ the extended-range UMPK-PD variant with larger wings, and even a version with a small turbojet engine that enables the bomb to hit targets some 200 kilometers away.[191]

Russian sources indicate that the manufacturing of FAB-500 and FAB-1500 has expanded, while FAB-3000 was resumed as of early 2024.[192] According to official documents from the US Department of State, between 2022 and 2023, the Tactical Missile Corporation received at least 80,000 PRC-origin servo motors valued at around $200m and intended for Russian defense end-users.[193] Assuming the use of two servo motors in a single baseline UMPK, that amount would have been sufficient to retrofit up to 40,000 bombs, though it is not possible to verify if the purchased servo motors were intended only for the production of UMPK modules, as they can also be used in other weapon systems.[194]

The same documents also confirm that KTRV "received millions of dollars' worth of PRC-origin servo motors" throughout 2024, thus hinting at a high-volume production of UMPK modules. This trend finds indirect corroboration in a February 2025 interview of KTRV's CEO Boris Obnosov, in which he announced that the company's employees rose from 66,000 to 90,000 over the previous two years, with a sevenfold increase in its production volume for the Russian Ministry of Defense.[195]

In a recent information release, Ukrainian military intelligence revealed a list of 31 companies involved in the manufacturing of the UMPK under the supervision of the Tactical Missile Corporation, with six enterprises still not subject to any international sanctions.[196]

Jet engine production

When it comes to jet engines, the Federal Statistics Agency of Russia suddenly started publishing data on production rates for 2024. It is not clear whether this is a result of some organizational aberration related to unknown changes in the agency's methodology, or an intentional decision motivated by unclear reasons. However, the numbers related to the Volga federal district correspond to what is known about the production capacities of the factories located in this district in the 2000s to 2010s, when these factories published detailed annual reports. In this way, we take these batches of statistical data as true.

If the published numbers are correct and not a part of a strategic disinformation campaign of Russia (which cannot be excluded), facilities located in Omsk produce more jet engines than all other Russian factories together, including the biggest jet engine plant, ODK-UMPO in Ufa. Numbers, however, likely reflect a blend between production of jet engines from scratch as well as repair and modernization work.

Another explanation is that the three other major jet engine factories in Moscow and Rybinsk — Chernyshev MMP, ODK-Salyut, and ODK-Saturn, respectively — did not seem to produce any engines at all in 2024 and 2025. It seems Chernyshev MMP and ODK-Salyut also went through consolidation and modernization of production sites at that time.[197] It is very likely that the three entities only produce components and parts for jet engines, which are then assembled in Omsk.

This situation implies a consolidation of the industrial segment. Russia likely transformed the manufacturing chain of small jet engines for cruise missiles by focusing several plants on one target: the production of as many TRDD-50 engines as possible for cruise missiles Kalibr, Kh-101, and Iskander-K (Kh-69 can be potentially equipped with this engine as well), and the repair of remaining R95-300 engines for the same cruise missiles from existing stockpiles as quickly as possible. This effort allows Russia to produce sufficient numbers of systems, use them against Ukraine, and even constitute a reserve.

Overall, despite ongoing difficulties, Russia seems able to sustain the current rate of fire of missiles. As part of the "missile debate," Moscow will not run out of systems any time soon, not least because the Kremlin has been quickly adapting production patterns to the demands of the war and changing tactics since 2022.[198] OPK manufacturing priorities have successfully adapted to the realities of the battlefield, for instance, by increasing production of Kh-101 and reducing output for Kalibr systems. A critical issue for the Kremlin relates to missile interception rates by Ukrainian forces and Kyiv's growing ability to repel Russian missile strikes.[199]

Figure 14: Jet engines manufacturing in Russia

By federal districts, 2024-2026.

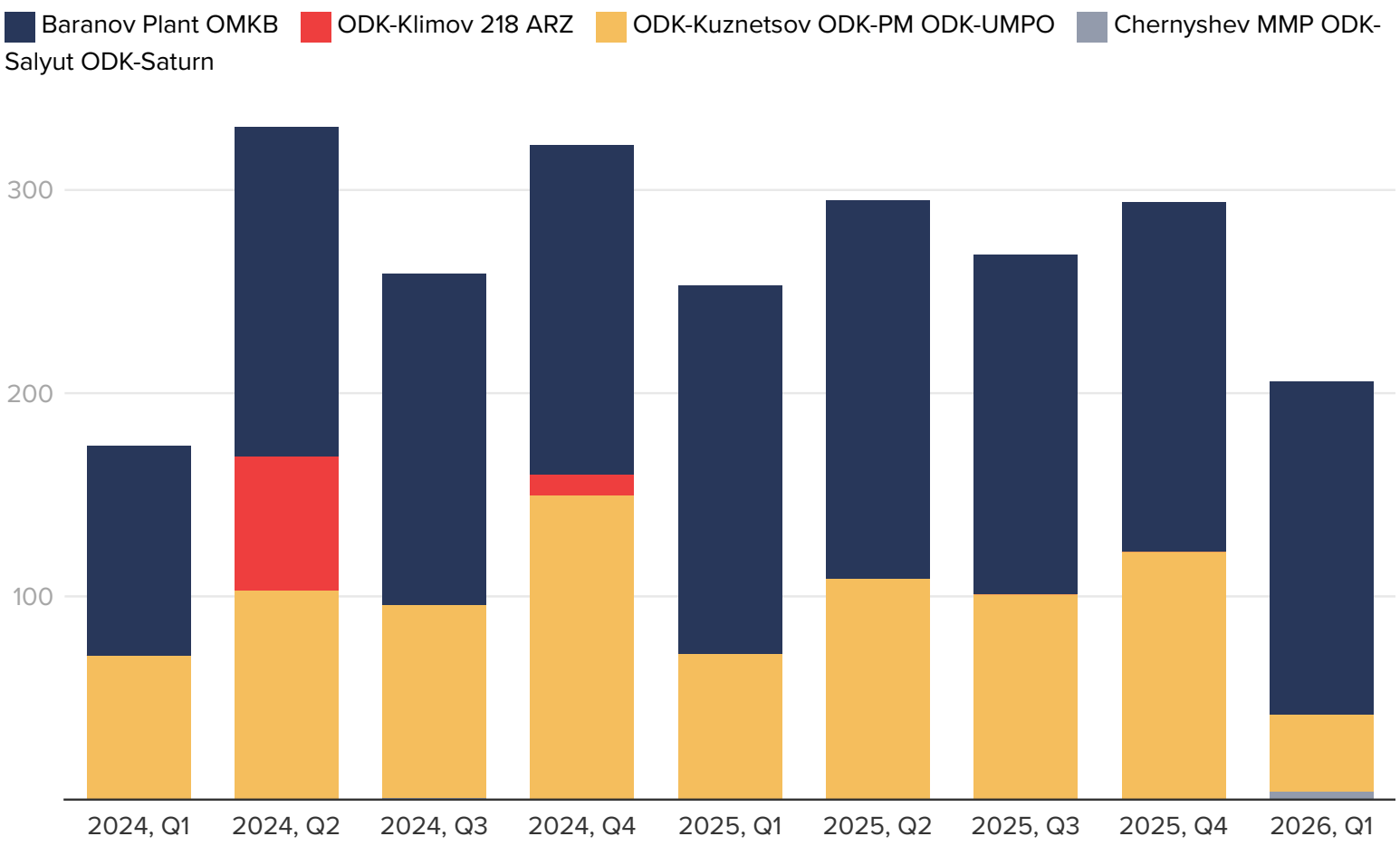


Chart: Polina Tsurikova/Center for European Policy Analysis • Source: The Federal Statistics Agency of Russia (Rosstat)

Chapter 3 — Adaptation and resilience: the example of "dronization" of Russia's military industry

Despite output constraints and industrial bottlenecks crippling the OPK, the Russian military industry has also displayed adaptation and resilience. Indeed, the full-scale invasion of Ukraine has accelerated a profound transformation in its defense-industrial base, placing unmanned systems at the center of military adaptation.

What began as a reactive effort to offset battlefield losses and technological constraints has evolved into a broader process of "dronization," whereby the shift toward new defense production priorities has moved alongside the attempt to leverage dual-use technologies by establishing a domestic civilian drone ecosystem.[200]

Under sustained sanctions and export controls, Russian industry has demonstrated a capacity to reconfigure supply chains, integrate commercial components, and scale output of relatively low-cost, expendable systems. This shift reflects a growing emphasis on mass, adaptability, and "good-enough" precision enabled by a distributed drone production ecosystem spanning state-owned enterprises, private firms, and volunteer networks. This expansion in unmanned capabilities will shape Russia's military effectiveness and defense posture well beyond the current conflict.

3.1 The evolution of domestic drone production

Domestic production patterns

In January 2024, the Russian MoD pledged a significant uptick in drone production for the military, encompassing practically all drone types, from short-range FPV-type and intelligence, surveillance, and reconnaissance (ISR) drones to mid- and long-range reconnaissance and combat models. For that purpose, the Ministry of Industry and Trade announced a three-year 100-billion-ruble budget exclusively dedicated to the development and production of drones.[201] Recently revised industrial output targets indicate that Russian authorities and defense-industrial leaders want to increase the percentage of domestically produced drones to 70% and achieve a level of technological sovereignty of 80%, producing up to 46,000 unmanned aerial systems per year by 2030.[202]

When looking at traditional OPK firms with established drone products, there has been a steady production growth in particular across the class of long-dwell reconnaissance UAVs used to provide situational awareness and target acquisition for Russian fires. These represent the backbone of Russia's ISR capabilities and are indispensable for its kill chains.



Image: Members of the police evacuation unit drive along a road covered with an anti-drone net as a Russian FPV drone is stuck in it, during an evacuation from the frontline village, amid Russia's attack on Ukraine, in Zaporizhzhia region, Ukraine August 20, 2026. Credit: REUTERS/Stringer.

The pool of reconnaissance UAVs Russia relies upon includes tens of different models. The most widespread systems include the SuperCam S350 from the Unmanned Systems Group of Companies, partially owned by Rostec; the Orlan (10 and 30), made by the Special Technology Center (STC) in St. Petersburg; and the Zala 416 family of systems, produced by the Zala Aero Group. While Russian authorities have moved to withhold output and trade data of drone companies from public registers, media reports confirm major efforts to expand production.[203]

Orlan-family UAVs remain widely used to provide in-depth ISR and target acquisition to Russian forces. Statements from the manufacturer indicate its Orlan-10 and Orlan-30 production has "increased three- to fourfold and 25-fold," respectively, since 2021, with more than 1,000 platforms produced per year as of the beginning of 2024.[204] Furthermore, late last year STC announced the adoption of a fully domestic four-stroke gasoline engine, which supposedly replaces the Japanese Saito FG-40 previously mounted on the Orlan-10.[205] While no details were provided, we assess that this is likely the DA40CH engine, an upgraded version of the FG-40 produced by the St. Petersburg-based NPO AMB.[206]

The manufacturer of the SuperCam acquired a 17,000-square-meter shopping center in Ryazan early last year, while a company's representative recently stated that the 2025 overall production of Unmanned Systems Group grew by 20% compared to the previous year.[207]

Izhevsk, in Udmurtia, has emerged as a key Russian drone production hub, with expansion enabled by the repurposing of shopping malls into UAV manufacturing facilities. In the spring of 2023, for example, the Zala Aero Group — part of the Kalashnikov concern — transformed the Italmas shopping mall into a drone manufacturing facility, while later the same year, the Izhevsk Unmanned Systems conglomerate (NPO IZHBS) acquired the New House shopping center to manufacture the Granat-4 UAV, with serial production launched in June 2024.[208] Finco LLC, which is part of NPO IZHBS, pledged a tenfold increase in annual UAV output during a visit by then-Defense Minister Sergei Shoigu in February 2024.[209] Similarly, Aeroscan purchased the Stolitsa mall in Izhevsk in September 2023, ordering the local businesses to vacate the premises by October of the same year.[210]

While authorities withhold precise numbers, these developments suggest that the combined yearly production of the above-mentioned fixed-wing ISR UAVs likely exceeds 10,000 to 12,000 units, though the potential for further expansion depends on component availability, workforce, and demand signal. For instance, leaked documents from 2023 revealed that NPO IZHBS failed to fulfill the government contract with the Russian Ministry of Defense due to the impact of European sanctions.[211]

Furthermore, while much of this output covers the needs of Russian forces in Ukraine, part of it is directed toward the civilian and foreign markets. In January of this year, Zala Aero Group secured contracts for aerial surveys of oil and gas infrastructure in Western Siberia and the Volga region, which adds to another deal with the Kursk Region Directorate of the Ministry of Emergency Situations.[212] In August 2024, the Unmanned Systems Group inked deals with Kazakhstan, Uzbekistan, and Belarus to supply the SuperCam complex.[213]

Attack drones and loitering munitions have emerged as one of the most visible and operationally consequential pillars of Russia's drone-centric transformation. Initially reliant on limited inventories, Moscow has progressively expanded domestic production and diversified its strike portfolio. These platforms embody a shift toward scalable, attritable capabilities designed to saturate defenses, strike deep targets, and impose persistent pressure on Ukrainian forces across the battlespace.

Attack drones and loitering munitions

As with reconnaissance UAVs, production of long-range and tactical strike drones has grown rapidly. By 2025, Russia was expected to produce at least 30,000 long-range attack/decoy drones annually. According to Rosoboronexport CEO Alexander Mikheev, the demand for drones will grow by 120% by 2030, and by 400% for loitering munitions.[214]

The most used long-range attack drone is the infamous Geran-2 (derived from the Iranian Shahed-136), manufactured and upgraded at facilities in the Alabuga Special Economic Zone in Tatarstan and at the Kupol Izhevsk Electromechanical Plant.[215] A December 2024 CNN investigation, citing Ukrainian intelligence, reported a 55% expansion of the Alabuga complex and output growth from 2,738 units in 2023 to 5,760 in the first nine months of 2024.[216] Current production is estimated at 200 to 300 units per day, including Gerbera decoys, with Ukrainian assessments indicating plans to triple output by 2026 to reach up to 1,000 daily launches.[217]

According to analyst Rob Lee, the Russian General Staff requirements are for a minimum of 87,000 one-way attack drones in 2026, with the State Defense Order plan aiming for 48,000 Geran-2 and Gerbera strike systems, 12,000 Geran-4 and -5, 48,000 Geran and Gerbera seeker variants, and up to 7,000 Garpiya-A1 attack UAVs.[218] Greater economies of scale would likely result in a lower per-unit cost, currently estimated at around $70,000.

A July 2025 report confirmed further expansion at Alabuga, including infrastructure to host over 40,000 personnel.[219] A key factor is the facility's vertical integration process, with mass production of the two-stroke piston engine using in-house forges that cast aluminum and steel bars.[220] It also produces circuit boards and carbon fiber cases, streamlining production.[221]

Zala Aero Group's notorious Lancet loitering munition has seen a sharp rise in use since mid-2023, with nearly 2,600 documented strikes in 20 months (about 123 monthly).[222] Accounting for underreporting, we can estimate a production output of at least a few hundred units per month to sustain the current operational use, with total annual output likely exceeding 5,000 to 7,000 systems across variants. The recent approval of the export-oriented Lancet-E suggests capacity to meet both domestic and foreign demand.[223] However, Ukrainian strikes on key suppliers, such as the August 2025 attack on the Zagorsk Optical-Mechanical Plant (ZOMZ), have caused recurring production disruptions.[224]

Besides the Lancet, Russia fields a growing range of tactical strike UAVs, notably the V2U and Molniya-2 barrage munitions. The former, with a 60 km range, features automated targeting enabled by AI chipsets typically based on Nvidia Jetson

Orin kits and relies largely on Chinese components, likely assembled by Kazan-based company Chimevrasia LLC.[225] The Molniya-2, produced by Atlant Aero in Taganrog, stands out for its low cost and simple design, enabling mass production — reportedly thousands per month — and making it a key asset for both tactical and deeper strikes.[226]

FPV drones

Since mid-2023, FPV drones have reshaped combat, forcing changes in force design, logistics, maneuver, and evacuation. As such, they deserve a dedicated section.

Until early 2025, most Russian FPVs, along with small commercial quadcopters used for short-range ISR, came from the country's sprawling volunteer network of individuals, organizations, and start-ups that fundraise for support among regular Russian citizens as well as wealthy individuals.

However, increasing state involvement — through partnerships and acquisitions by major OPKs like Kalashnikov — has begun shifting production toward industrial scale.[227] Estimates remain uncertain: Back in 2023, some Russian volunteers reported outputs of up to 100,000 monthly, while a June 2025 media article citing Ukrainian intelligence stated that Russia was planning to produce 2 million FPV drones by the end of the year.[228] In the same period, for example, the Ushkuynik Center reported monthly outputs in the tens of thousands for specific models like the "Prince Vandal" fiber-optic FPV.[229] Notably, these numbers refer only to a single FPV model from one manufacturer, with tens of models and variants being used by Russian forces in Ukraine.

Even if exaggerated, these figures indicate constant access to Chinese components and Russia's intention to increasingly rely on FPV drones as cheap, expendable tactical weapons well into 2026 and beyond.[230] Overall, we estimate Russia's FPV drone production capacity likely exceeds 2 million units annually, with potential growth to 3 million in 2026.

Medium-altitude long-endurance drones

Production rates have reportedly increased for Russia's main large multirole fixed-wing drone, the Orion, which is produced by the Kronstadt Group at the Dubna Machine Building Plant in the Moscow region. The facility underwent expansion work between 2021 and 2022 and switched to three-shift operations at the end of the same year.[231] Little information is available about Orion's yearly production rate, which is likely in the two-dozen range, given the system's complexity.

The company's substitution efforts have reduced but not eliminated key dependency issues. By 2022, imported components in the APD-110/120 engine, Russia's

alternative to the Austrian Rotax 914 engine, developed by Agat JSC, accounted for only 3.6%, though they included essential parts such as the exhaust system.[232]

The Orion has been deployed widely during operations in Ukraine, though its role has been limited by its vulnerability to air defense, with at least 11 documented losses since 2022.[233] In December 2023, Kronstadt completed deliveries to the Russian military ahead of schedule and secured export orders, including with an undisclosed Asian country, though Ethiopia is the first and only official customer of the Orion-E (the export version) as of March 2026.[234]

Overall, evidence clearly indicates that despite intense international sanctions, Russia not only has sustained domestic drone production but has also increased output, enhanced system performance, and broadened the spectrum of unmanned platforms it fields.

3.2 Challenges and limitations to Russia's "dronization" of the military industry

Indigenization attempts: a half-empty glass

In the drone segment, Russia has reported advances in domestic production and localization of certain parts and subsystems, though critical materials are still largely sourced abroad, while assembly, testing, and validation happen in Russia. In 2015, for instance, Zala Aero reported that the company's cascade approach to production allowed it to localize almost entirely the manufacturing process, but no further details were provided on the origin of the components.[235]

Recent statements from Russian drone experts and manufacturers indicate an average component localization of 50 to 60% (likely inclusive of both civilian and military production), with a 10 to 15% year-on-year growth.[236] Examples include mass-produced UAV microcontrollers by the Research Institute of Electronic Technology (NIIET) — part of the Element Group — and the serial manufacturing of UAV engines, including small and heavy-duty electric motors by Motorsky (a firm associated with the Skolkovo Innovation Center) and the Spektr Design Bureau.[237] At the same time, the same experts also remarked that the success of localization efforts is uneven and varies significantly depending on the type of drone or component, with electro-optical and thermal sensors, microchips, and navigation systems remaining the Achilles' heel, and being almost entirely imported.[238]

By comparison, a 2023 study found that around 69% of critical UAV components (across Geran, Orlan, and Lancet types) originate from US-owned companies, with 60% of imported parts produced in China (often at plants owned by Western firms), with additional supplies coming via Taiwan, Malaysia, Vietnam, and even the EU.[239]

Overall, Russian data on drone production localization should be taken with a grain of salt. While indigenization attempts have likely yielded some results in the past two years, more recent findings on Geran UAVs highlight continued reliance on Western-made parts (notably German transistors) and a shift from US components — around 80% in 2023 — to cheaper Chinese alternatives, now exceeding 60%.[240] Furthermore, recent private statements from key Russian manufacturers released by Ukrainian hackers seem to confirm an almost complete reliance (around 90%) on Chinese raw materials and components for certain drone platforms, in particular electronics and plastics.[241]

China also underpins the rise of fiber-optical drones used by Russia (and Ukraine) since 2024, due to its dominance in the global production of optical fiber, assessed at more than 60%.[242] Although Russia previously met 30 to 40% of domestic demand for optical fiber through the JSC Optical Fiber Systems in Saransk, which provided around 4m kilometers annually, production halted after Ukrainian strikes in mid-2025 and is unlikely to resume before the end of 2027, making imports indispensable for Russian drone companies and other civilian enterprises.[243]

The "dronization" paradigm

In September 2025, the Russian Ministry of Defense stated that "roughly 80% of Russian strike missions in Ukraine were carried out using UAVs," with efforts focused on improving the command-and-control infrastructure for their use.[244] In 2024, the Ministry of Industry and Trade allocated 100 billion rubles over three years for drone development and production.[245]

Recognizing the centrality of drone warfare, the Russian government, backed by Putin himself, launched various policies to accelerate and expand UAV production for both military and civilian purposes, while also promoting a "drone culture" within Russian society. This dual-track approach exemplifies the close interconnection between the civilian and military efforts to develop and integrate uncrewed systems in the country.

First, the Kremlin announced the "Strategy for the Development of Unmanned Aviation up to 2030," with the ambitious goal of unlocking between 660bn and 1 trillion ruble ($8.2bn to $12.4bn) investments in the drone industry by 2030.[246]

Second, it established an entirely new military branch for unmanned operations (Ukraine did the same a few months earlier), supported by Russia's first Higher Military School of Unmanned Systems.[247]

Third, the Ministry of Industry and Trade launched the National Project "Unmanned Aviation Systems," which, while primarily focused on the civilian sector, anchors drone component development within state planning. This ambitious initiative has over 283bn rubles ($3.5bn) earmarked for R&D, industrial scale-up, and the creation

Table 4: Selected regional hubs for drone production

Selected regional hubs for drone production

Region	Key Initiatives	Federal Support	Production Focus
Rostov Oblast	Scientific-production center for unmanned aviation systems	Federal subsidy for equipment	Military and civil UAVs
Tula Oblast	Federal project for development, standardization, and serial production	National project "Development of Unmanned Aviation Systems"	Up to 2,000 drones per day
Khabarovsk Territory	AERO-KHT assembly production in Khabarovsk Special Economic Zone (TOR)	Special Economic Zone designation	Small strike-reconnaissance UAVs (Veles)
Karelia	Scientific-production center for UAV development	Federal funding	Design, testing, manufacturing of drones and components
Tambov Oblast	Special Economic Zone (OEZ) formation	Investment attraction mechanism	Industrial drone production
Nizhny Novgorod Region	Federal support for new production facilities	Long-term military orders	Prince Pozharsky drones and regional cluster
Leningrad Oblast (Vsevolozhsk)	Cluster for support of civilian defense production	Regional initiative	UAV production support
Altai Krai	Large agricultural drone development (40+ kg payload)	Regional production	Agricultural and industrial drones
Tatarstan (Zhogi)	Republican Center for Unmanned Systems (RCBS)	Regional center	Training, repair, modernization of UAVs

Table: Center for European Policy Analysis • Source: Authors' elaboration based on open-source information.
The list is not exhaustive.

of 48 regional research and production centers through the end of the decade.[248] As of March 2025, the network of such centers spanned across 18 Russian regions, which along with special economic zones (such as Alabuga in the Tatarstan region), are receiving targeted subsidies and infrastructure investment to decentralize production.[249]

Additionally, the Ministry of Industry and Trade also introduced a special "dronization" score that measures the level of UAV adoption in production and training across the country, with mandatory participation introduced this year.[250]

Equally important, the government has introduced fiscal incentives for drone manufacturers, including subsidies covering up to 80% of R&D costs, VAT exemptions for dual-use drones and components (until 2027), grants up to 100m rubles per project, and expanded income tax deductions such as zero-rate income tax for the first five years of new production.[251]

State procurement contracts are intended to ensure stable demand and offset development risks. Nevertheless, many companies have reported bureaucratic obstacles in accessing state funds and meeting state procurement targets of civilian drones under the UAS National Project.[252]

In parallel, Russian authorities are promoting what we may define as a "drone culture" to incentivize the sector's development and, more subtly, build a large recruitment pool for the newly created "Unmanned Systems Force," currently counting 80,000 personnel and projected to nearly double by 2026.[253] Initiatives include the adoption of the country's first school textbook on operating unmanned systems — published by Kremlin-tied drone company Geoscan — within the federal education curriculum last year, and a nationwide university recruitment campaign, launched in late 2025, featuring over 200 events promising highly remunerative one-year contracts.[254] According to a recent investigation, Russian educational institutions, including kindergartens, have spent around $210m (16bn rubles) on drones and related material for training students since 2022.[255]

Another key enabler of this dronization process is the industry's aggressive labor strategy targeting students, foreigners, and even underage workers, hired through partnerships with technical schools and colleges and the promise of competitive salaries.[256] A simple search on a Russian jobs website, for instance, returns multiple vacancies in the UAV industry, including at the Alabuga plant near Kazan, with monthly salaries starting at 127,500 rubles, which is 55% higher than the average monthly wage in the country.[257] Furthermore, many UAV companies, including Albatross and Kronstadt, have transitioned to a virtually uninterrupted production pace, with three shifts per day, six or seven days per week.[258]

Against this backdrop, a fragmented but fast-growing industrial ecosystem has emerged, driven by soaring demand from operations in Ukraine. According to official Russian sources, the drone sector now involves over 800 enterprises — mostly small and medium-sized businesses — whose number has doubled in the last three years.[259]

Leveraging volunteer drone production

As in Ukraine, a patchwork "garage" and volunteer drone production initiatives emerged in Russia by mid-2022. We argue that the impact of this phenomenon on Russia's operations and adaptation has been largely underestimated. Since then, these groups have trained thousands of drone operators and likely supplied Russian units with a few million small tactical drones.

Relying largely on commercial platforms such as DJI, Autel, and combat FPV quadcopters, volunteer efforts helped mitigate the early shortcomings (for instance, the lack of dedicated small quadcopters for close ISR) or limited production capacity of the traditional defense industry. Commercially available components, typically of Chinese origin, are funded by online donations through a network of Telegram and VKontakte channels.

Over time, some of these initiatives have evolved into influential actors, to the point of signing partnerships with larger defense conglomerates. This aspect is important because, as prime defense actors acquire or absorb the most promising volunteer efforts, they provide an avenue for linking innovation with mass production, reaching orders of magnitude larger outputs.

A key example is Sudoplatov, which by October 2023 reportedly assembled around 1,000 first-person-view (FPV) drones across 20 sites, combining manual assembly with 3D printing.[260] Its popular PVH-1 (VT-40) model, manufactured by the Moscow-based Rustakt plant, has seen widespread use by Russian units and benefited from state financial backing.[261] Despite reported reliability issues and an official halt in cooperation with the Ministry of Defense in 2024, the initiative continued receiving funding through the Department of Advanced Inter-Service Research and Special Projects as of early 2025.[262]

Other notable efforts include the Archangel project, a nationwide volunteer network focused on training support and innovation, which partnered with the Kalashnikov concern in August 2025 to scale promising FPV and other drone designs.[263] The "Ghoul" (Упырь) project similarly expanded from crowdfunding-based drone workshops to centralized production at Uraldronzavod, in the Sverdlovsk region.[264] Additional initiatives — such as KatyaValya, Dva Mayora, Voron FPV, and the St. Petersburg–based design bureau Hortensia — combine large-scale drone production, pilot training, and supply delivery to front-line units.[265]

Together with more centralized production efforts, such as the Piranha FPV made by the Simbirsk Design Bureau in Ulyanovsk region and the Veles FPV produced by Aero-Hit in Khabarovsk, these initiatives have been instrumental in sustaining Russia's operations in Ukraine.[266]

Tensions with the state and other challenges

Volunteer drone initiatives emerged in response to bureaucratic inertia, slow procurement, and the outdated approach of Russia's defense sector. Early efforts like Sudoplatov and Archangel often operated in parallel to the Ministry of Defense, which traditionally resists external competition. Despite their major impact, these initiatives have both contended with and resulted in systemic challenges for Russian drone operations.

First, they face persistent bureaucratic barriers, including delayed payments, procurement hurdles, denied facility access, and unrealistic paperwork requirements when sourcing components through gray channels.[267] Many groups remain wary of state involvement, fearing loss of flexibility, while reliance on crowdfunding makes them vulnerable to policy shifts and funding volatility.[268]



Image: Russian President Vladimir Putin visits the Irkutsk Aviation Plant, a branch of Yakovlev, part of the United Aircraft Corporation (UAC) under Rostec, in Irkutsk, Russia July 24, 2026. Credit: Sputnik/ Vyacheslav Prokofyev/Pool via REUTERS.

Second, increasing centralization risks stifling innovation. Since 2024, the Ministry of Defense has sought tighter control through the Rubicon Center and the Unmanned Systems branch, pushing for standardized training and procurement while absorbing high-performing volunteer groups into formal structures.[269]

Third, the proliferation of small-scale producers since 2023 has created uneven quality and poor standardization, limiting interoperability, particularly for FPV drones.

Fourth, supply chain constraints and competition for components affect production speed, scale, and reliability. While greater state control may improve standardization, it risks undermining the rapid iteration and creative problem-solving that underpin volunteer success.[270]

Overall, authorities tend to frame these initiatives as civilian tech innovation rather than combat drone production, both to attract younger talent and to avoid providing too big a stage for private initiatives that may eclipse the role of the state and highlight its failures.[271]

Chapter 4 — Implications

Russia's OPK faces a contrasting situation marked by extreme resilience under pressure, as exemplified in the drone industry, and the overwhelming challenge of managing ongoing output constraints (exhaustion and attrition) and industrial bottlenecks. This situation further affects the elite surrounding the OPK and the Kremlin as well as the way Russia will continue to project itself as a threat to Ukraine, NATO, and their allies.

4.1 Elite network adaptations

The ideologically consolidated network of military elites involved in decision-making on Russia's military strategy and war planning now plays a major role in allocating federal budgetary resources.[272] The military elites all have a vested interest in restoring Russia's military power, avoiding strategic defeat in Ukraine, and furthering the war effort. Furthermore, they have considerably extended their clout across all spheres of society and the rest of the federal administration.

Meanwhile, the OPK emphasizes the need to keep arms procurement at the highest levels for at least a decade after active warfare in Ukraine ends to rebuild depleted stockpiles and address imbalances and issues within the sector.

Within the changing political economy of the OPK, the Russian leadership has also faced fundamental challenges. The rise in arms manufacturing required a complete overhaul of power structures to support continually increasing production rates. The key question is whether the current economic governance model provides enough resources for the armed forces, security services, and the OPK, or if an "administrative command" model of the economy needs to be developed and fully implemented.

In other words, an almost complete takeover of the economy by the Russian state-owned entities, like banks and major industrial corporations, and cronies of the Russian leadership except some minor segments like food retail, consumer services, and some manufacturing segments.

The model would not look like the Soviet state planning commission (*Gosplan*); it would be closer to what took place in Nazi Germany, boosted by modern computing for centralized economic governance.

Such a model would leave only a few sectors unaffected by state control, such as small and medium-sized enterprises. An administrative-command model will lead to strict regulation of foreign trade; bureaucratic redistribution of available financial, human, and materiel resources from the lower-priority sectors (read, civilian) to

the top priority ones (anything linked to dual-use and military applications); and restrictions in consumer goods and services markets.

Moving toward that model would require major government changes, further weakening the relatively moderate, less hawkish members of the regime. In this, the head of the government, Mikhail Mishustin, the minister of finance, Anton Siluanov, and others who pretend to play the role of "technocrats" would be replaced by much more ideologically charged individuals such as the current defense minister, Andrei Belousov, or the head of Promsvyazbank, Petr Fradkov.[273]

Within the security sector, some high-ranking military commanders, heads of state-owned OPK companies, and even leaders of security and intelligence services would also likely be replaced due to their reluctance to adopt a more confrontational stance on domestic political and economic issues. Such changes have recently occurred, such as the replacement of United Shipbuilding Corporation head Alexei Rakhmanov[274] and Roscosmos director Yuri Borisov[275] with younger managers in 2023 and 2025, respectively.

The heads of Rostec, Almaz-Antey, KTRV, and Rosatom hold much stronger positions within the Russian power hierarchy and depend on extensive networks of loyal subordinates and protégés.[276] However, these networks might reconfigure and force changes in power in the near future.

Another aspect of administrative changes is the increasing competition among OPK entities for shrinking resources amid the industry's decline. OPK entities compete more and more for the same pool of qualified workers and engineers, as well as for access to advanced machine tools and components.[277] This situation indicates an uneven game of lobbying, cronyism, and vested interests working to secure access to resources needed to meet production demands.[278] While some companies will succeed, others will ultimately fail. Consequently, these increasing imbalances demand much stronger political and administrative oversight of the OPK and the whole economy.

4.2 In search of a "tipping point"

Most of the equipment currently used by the Russian armed forces in Ukraine consists of refurbished and adapted systems from federal stockpiles. However, since hardware always needs ongoing maintenance, there is probably a limit to how useful second-hand systems can be. In other words, the OPK cannot just tinker its way out of the war.

Meanwhile, the development of genuinely "new" platforms built from scratch still faces overwhelming challenges in the industrial sectors discussed throughout this paper, worsened by known industrial bottlenecks. Structural problems in the

OPK cannot compensate for battlefield losses or the exhaustion of refurbishment capacity.

In this, the Russian OPK is currently going through a form of chain reaction:

- The war against Ukraine consumes both existing stockpiles and new production faster than they can be replaced and repaired,
- As the demand for MRO and new production increases, this strains military logistics, maintenance, and machine tools,
- As factories and production chains are pushed to the brink, they are confronted with longstanding industrial bottlenecks and qualified labor shortages,
- In the absence of genuine solutions, this situation leads to the managed degradation of the OPK.

The result is not a more resilient military-industrial base, but a narrower and more fragile one.

Despite the resilience the OPK has shown since 2022, wartime adaptations are only temporary, and the OPK will eventually deplete existing stockpiles and exhaust its ability to repair damaged equipment. Between continued hardware production and efforts to reduce input bottlenecks, the depletion of Russia's legacy stockpile might be the most pressing issue.

The future of Russia's military industry will not be determined by outright collapse, but by a gradual tipping point. Indeed, the current situation could reach a "tipping point" and ultimately lead to the unraveling of specific OPK segments. This tipping point is not uniform across industrial sectors: It may emerge earlier in heavy equipment, for instance, or later in areas where the OPK retains advantages (such as missile systems and drones).

Ultimately, the OPK will keep muddling through with "good enough" weapons systems to meet the demands of the war. The military industry will produce what it *can* produce — not more, not less. However, Russia might be forced to simplify military production entirely, not by choice but out of necessity.[279]

4.3 Accelerating the decline of the OPK

How the international community can accelerate the aforementioned chain reaction, reach a tipping point, and ultimately further the degradation of the Russian military industry has significant implications.

Continued pressure through international targeted sanctions against Russia is necessary, notably the expansion of sanctions on dual-use sectors and military-related segments that enable the production of weapons. This report identified the

key dependencies of the OPK and outlined the need to degrade entire parallel industrial segments working for the military industry:

- Cotton and specialized chemicals for explosives manufacturing,
- Military-grade metallurgical products and special steels,
- Machine-building tools, especially computer numerical control (CNC) tools,
- Civilian, dual-use, and military-grade microelectronic components and semiconductors.

The objective should be to break down the Russian OPK from the ground up, namely, from the very inputs and raw materials that will eventually become output constraints, leading to exhaustion and attrition. Further efforts are also required to strengthen secondary sanctions enforcement, address export control loopholes, and dismantle sanctions evasion schemes.

Although sanctions may have reached their limits in effectiveness and enforcement, there remains room to provide Ukraine with additional military support. Continued military assistance for Ukraine is the most effective way to indirectly deplete Russian stockpiles. Indeed, increased military pressure on Russian forces will make advances harder for the Kremlin and lead to higher rates of equipment loss. Supporting Kyiv's strike capabilities also enables the continued degradation of OPK production chains, critical nodes, and manufacturing capacity.

4.4 What to expect from a militarily aggressive Russia

A final aspect concerns Russia's future as a militarily aggressive country, specifically the military-industrial lessons learned from the full-scale invasion of Ukraine. Since 2022, the Russian OPK has demonstrated its ability to handle wartime procurement challenges and increase production pace.

The main shift has been toward mass production of drones, precision-guided munitions, and glide bombs, reflecting a hard-earned response to the changing nature of the war against Ukraine and compensating for the limitations of traditional artillery.

Moscow's heavy dependence on tube and rocket artillery, often seen as the core of Russian operational doctrine, has been gradually challenged by Ukrainian dispersal of forces, unprecedented battlefield transparency, and more effective targeting and counterbattery fire from Kyiv's troops. These changes have reduced the benefits of high fire volumes, while making Russian artillery units more vulnerable to rapid detection and attrition, compounded by growing logistical issues and intermittent shell availability, especially since 2023.

In response, Moscow directed extensive resources toward enhancing and accelerating its targeting process by integrating persistent surveillance assets with faster, more precise strike systems, particularly reconnaissance and strike UAVs, glide bombs, and cruise and tactical ballistic missiles.

This shift, which involves doctrinal and organizational changes as well, aims to turn detection into effects before targets can relocate or disperse, thereby restoring lethality and tempo in situations where massed fires alone no longer provide a battlefield advantage. However, the focus is not solely on precise accuracy, but on strike capabilities that are "good enough," affordable, and capable of being mass-produced.

The demands of the war have also taught the armed forces to procure the most effective weapons systems and platforms, thereby forcing a form of "natural selection" within OPK production. This is, in essence, what the Kremlin calls the "prioritization of procurement" that will inform key industrial segments in the upcoming State Armament Program (GPV) 2027–2036.[280]

The new GPV will emphasize specific priority systems, such as drones, precision-guided munitions, air defense systems, heavy land platforms, and electronic warfare (EW) systems (in addition to the continued modernization of the nuclear triad).[281]

Finally, it matters how the Kremlin envisions future warfare and, accordingly, which weapon systems will be needed to continue deterring Western countries and keeping NATO assets at risk of destruction. As the OPK continues to degrade, Moscow might be forced to reassess its ability to remain a credible military threat and to adapt doctrine and strategy to cold industrial realities. Nevertheless, a "low-tech" Russia will not necessarily mean a Kremlin that is less dangerous, aggressive, or prone to risk and escalation.

Conclusion

War contingencies have compelled the OPK to streamline its approach to mass production, stockpile management, and ongoing platform modernization, renovation, and overhaul (MRO).

For the foreseeable future, Moscow's main challenge will be to manage both industrial bottlenecks and output constraints, namely, to balance the depletion of the current stockpile (exhaustion) against the slower rate of domestic production (attrition).

To adapt to the shift from production to industry-wide MRO, the OPK launched a significant transformation of domestic manufacturing chains, focusing on increasing alteration rates rather than producing new systems from scratch. In other words, the OPK is shifting from being a manufacturer to a tinkerer of weapon systems.

The resilience demonstrated in the drone segment also provides evidence of how the OPK has been adapting under constraints. The success of this particular segment is due to a combination of political, military, and industrial factors, notably the creation of a "drone culture" and lower supply chain and production demands.

Yet in most segments of the OPK, the Kremlin is eroding the very industrial and material foundations that sustain war in the first place. Indeed, existing solutions and adaptations only deepen the very structural weakness they are meant to address.

The Russian OPK is adapting tactically, while structurally deteriorating. It can manufacture enough weapons to continue prosecuting the war, but increasingly only by simplifying production, lowering quality, and ultimately sacrificing long-term capacity for short-term battlefield endurance.

As the OPK constantly tries to stay ahead of inevitable degradation, short-term solutions create new fragility elsewhere: Stockpile consumption accelerates battlefield exhaustion, constant refurbishment strains logistics, surge production degrades production tools and labor, and dependence on China and third-country suppliers merely replaces one external vulnerability with another.

Moving forward, the Kremlin will have to manage the OPK's decline rather than reverse it. The tipping point is therefore not whether Russia can continue manufacturing weapons, but how long it can keep producing without crossing the threshold at which adaptation gives way to systemic failure across several segments of the military industry.

The result is a model of managed degradation of the Russian military industry, one that allows Moscow to sustain the war in the short to medium term, while progressively eroding the quality, sustainability, and future potential of its military power.

List of Acronyms

Armored Personnel Carrier	APC
Armored Repair Plant	BTRZ
Computer Numerical Control	CNC
Countering America's Adversaries Through Sanctions Act (2017)	CAATSA
Digital Scene Matching Area Correlator	DSMAC
First-Person-View (relating to drones)	FPV
Infantry Fighting Vehicle	IFV
Izhevsk Unmanned Systems Conglomerate	NPO IZHBS
Main Battle Tanks	MBT
Khabarovsk Special Economic Zone	TOR
Material-Technical Services	MTO
Military-Industrial Complex	OPK
Ministry of Defense	MoD
Modernization, Renovation, and Overhaul	MRO
Multiple Rocket Launch System	MRLS
Precision-Guided Munitions	PGM
Republican Center for Unmanned Systems	RCBS
Research Institute of Electronic Technology	NIIET
Special Economic Zone	OEZ
Special Technology Center	STC
State Armament Program	GPV
State Defense Order	GOZ
Tactical Missile Corporation	JSC
Tactical Missiles Corporation JSC	KTRV
Tank Support Combat Vehicle	BMPT
United Aircraft Corporation	UAC
Unmanned Aircraft System/Unmanned Aerial Vehicle	UAS/UAV
Uralvagonzavod	UVZ
Zagorsk Optical-Mechanical Plant	ZOMZ

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