



EUROPE

Looking ahead

Enablers of innovation and
scale for the future of Ukraine's
defence-industrial base

Stuart Dee, Katja Fedina, Kiran Suman-Chauhan,
Evie Graham, Daniel Hill, Andrew Gibson



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Executive summary:

- Ukraine's defence-industrial base has developed in conflict. It is setting global standards for innovation and technology iteration but doing so in an extraordinary budgetary and regulatory context. Robustly defining Ukraine's competitive advantage will inform the structure of longer-term defence-industrial planning.
- Ukraine's competitive advantage is derived principally from its skilled and combat-experienced workforce, societal buy-in to defence and strong alignment between government strategy and defence-industrial and economic planning. Perceptions of corruption and complexity and an unclear demand signal environment, however, constrain inward Foreign Direct Investment (FDI).
- Whilst Ukrainian society and industry have rallied to set up a unmanned aerial system (UAS) production ecosystem which is world-leading in terms of its technological capability, Ukraine's significant domestic demand buoys this ecosystem, driven by an unsustainable level of defence spend as a percentage of gross domestic product (GDP). Longer-term defence-industrial success will require a transition to export orientation, but this is unlikely to be product-led. Instead, it is Ukraine's innovative capacity and skills that are likely to drive future export success.

Recommendations:

To address these challenges, the Ukrainian Ministry of Digital Transformation (MDT) can focus on:

- Continuing to broaden the scope and international appeal of the 'Danish Model' of international aid based on investment rather than direct military aid. This model drives a familiarity with Ukraine's defence-industrial capability and enables domestic development to take precedence over sustainment of equipment. This should broaden longer-term prospects for FDI.
- Developing a skills retention and reshoring strategy, focusing on accelerating the return of skilled Ukrainians to support Ukraine's longer-term industrial base. This in turn will support efforts to bolster the non-defence economy as Ukraine gradually transitions away from its currently high levels of defence spending as a percentage of GDP.
- Commoditising Ukraine's innovative capacity and experience by seeking to compete internationally as a services integrator, rather than solely on a product exports basis. Whilst the market for UAS is increasingly competitive and will likely carry high regulatory burdens for Ukrainian outputs, Ukraine's capacity to procure and iterate at pace are key requirements for allied armed forces.

The MDT asked RAND Europe to define the key enablers and challenges to Ukraine's ability to increase defence-industrial production in relation to the MDT's core areas of competence. For the purposes of this analysis, we define this to be defence-industrial output relating to the digitally embedded technologies considered in this wider package of work, principally UAS. The analysis that follows considers broad trends defining the competitive positioning and longer-term sustainability of Ukraine's defence-industrial base writ large. The primary focus is UAS production, inclusive of subsidiary and adjacent technologies including uncrewed underwater vehicles (UUVs).

To systematically assess Ukraine's structural strengths (and weaknesses), we used Porter's Diamond Model as a robust pre-existing framework for analysis of competitive factors. This then informs our analysis of future and long-term Ukrainian defence-industrial positioning. The theoretical model was supplemented by expert insights garnered through a series of interviews.

Context and challenges

The Ukrainian defence-industrial base is rapidly evolving in the context of the ongoing conflict. Ukraine's battlespace is being reshaped by technological change, which is prompting a chain of continuous innovation between units in the field and their industrial suppliers. As Ukraine's innovative capacity grows, and its allies and partners continue to look for ways to support its military capabilities, this chapter

considers the primary challenges and enablers to increasing domestic industrial output. It seeks to identify pre-existing strengths that can be exploited and to draw attention to potential for accruing long-term advantage. The current objectives for the Ukrainian defence-industrial base are threefold:

1. To sustain the ongoing war effort and harness innovation at pace.
2. To restore the means of production damaged by the Russian invasion.
3. To generate defence-industrial capabilities based on competitive advantage that can be sustained in the long term and align to Ukraine's longer-term recovery and economic development strategy.

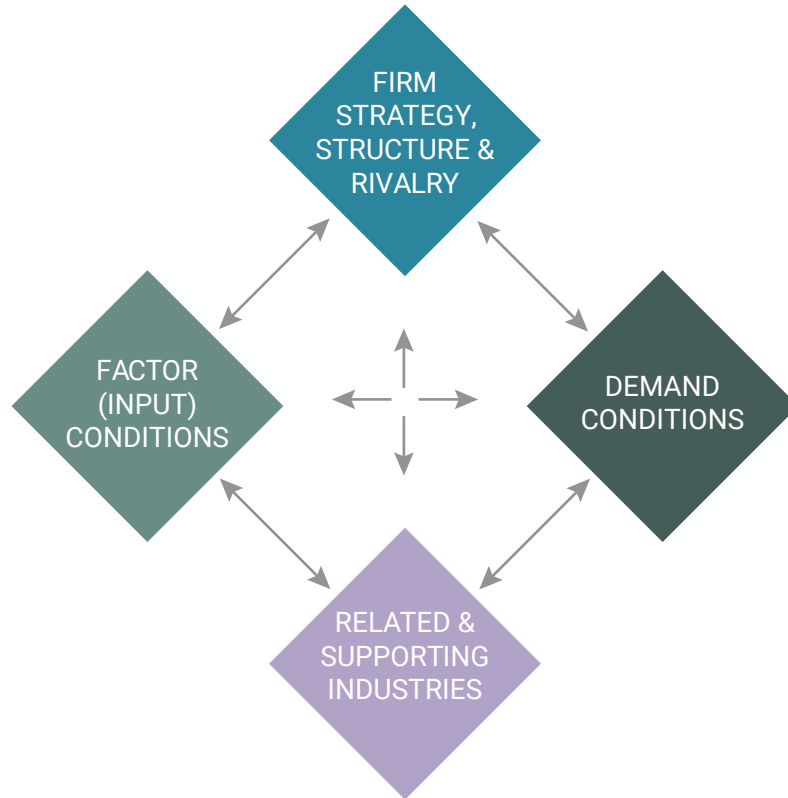
Analytical framework

To systematically assess key industrial enablers, we have adopted Porter's 'Diamond Theory of National Advantage' model, having assessed this as the most helpful analytical framework to capture key enablers for defence-industrial innovation and ramp-up. The simplified model elements are shown in Figure 1. This model is driven by an assessment of input factors, demand conditions, strategy and rivalry in the international market, and the roles of supporting industries. It has recently been used in studies to assess the options facing the European defence industry in its collective rearmament efforts. Our analysis using this tool accounts for Ukraine's specific context as well as the inherent nature of defence as a monopoly-monopsony¹ sector defined by specific demand conditions led by the national government.²

1 Retter et al. (2021).

2 Mueller (2024).

Figure 1. Simplified model of Porter's Diamond Theory of National Advantage



Source: Harvard Business School Institute for Strategy and Competitiveness.

Ukraine's competitive position

Factor input

Industrial relocation

Ukraine's industrial positioning benefits from its large landmass. Russian military operations since the launch of the full-scale invasion in 2022 have significantly damaged pre-existing manufacturing capacity, but Ukraine's defence-industrial base has demonstrated a capacity to reshape to address necessity. One response has been the formation of defence production based

on a disaggregated model of small/medium-sized production locations as opposed to a more traditional model based around small numbers of large production sites. Several defence production sites have been shelled and the effects on metallurgical production, where 80 per cent of enterprises are located in regions affected by ongoing hostilities, have been significant.³ Russian drone campaigns have targeted electricity generation, which has been hampered since the spring of 2024, and most recently gas production infrastructure.⁴ Since then, pressure to relocate electricity production has risen, particularly because

3 Jacoby (2025); Milakovsky & Vlasiuk (2024).

4 Liahovska & Koval (2024); Malenko & Polityuk (2025).

private companies working to maintain stations and repair damage are struggling to absorb the costs of reconstruction. Relocation of manufacturing for UAS is considered to be a more cost-effective and viable option than active protection measures for industrial sites.⁵

Since 2022, there has been an increased emphasis on regionalisation and integration of local supply chains.⁶ Rather than having to remodel a centralised industry, Ukraine can model its longer-term defence-industrial formation around this necessary reshaping. Private sector involvement is already supporting this effort as non-traditional defence suppliers have joined the national production effort in UAS and have generated elements of innovation. Studies of Ukraine's changing industrial geography show that relocation has more commonly been prioritised in export-focused industries than those producing for the domestic market.⁷ Analysts have suggested that exporting firms are generally more productive, dynamic and resourceful, which, in turn, leaves them better positioned to adopt complex and costly strategies like relocation.⁸ Early data has also shown that the most popular relocation pathways have kept firms within the Kyiv region. This likely results in less disruption to supply chains and distribution, whilst still mitigating some of the risks of damage, but is less helpful in reducing overall concentration.⁹

Labour force

The skilled workforce available to sustain Ukrainian defence is of critical importance to Ukraine's ongoing UAS production. The displacement of over a third of the population after the Russian invasion was the largest European migration since the Second World War.¹⁰ This shift led to significant geographic and sectoral mismatches in labour supply and demand, as well as specific staffing shortages across the defence industry, as 30 per cent of its employees were veterans and were mobilised to the armed forces.¹¹ The Ukrainian defence-industrial base has, nevertheless, continued to maximise the potential of its existing workforce because of three key qualities: high standards of technical education; reduced obstacles to entering the defence labour market; and wider societal resilience.

Ukraine is increasingly being recognised by external partners for its highly educated and technically advanced population.¹² The extensive adaptation and innovation demonstrated since 2022 has highlighted the flexibility of Ukraine's knowledge-intensive industries, but analysts have noted that despite this, a substantial part of Ukraine's ability to attract international investment depends on providing access to this skilled labour.¹³ Existing studies emphasise the need to invest in sustaining high levels of technical education, encourage the labour force to return to Ukraine,

5 SME interview by authors, 17 March 2025.

6 SME interview by authors, 14 February 2025, b.

7 Coniglio et al. (2024).

8 Coniglio et al. (2024).

9 Opendatabot (2024).

10 Dnipropetrovsk Investment Agency (2023).

11 Hmyria et al. (2024).

12 Dnipropetrovsk Investment Agency (2023).

13 Hmyria et al. (2024)

and work to mitigate the shortages caused by industrial relocation.¹⁴ There is also latent potential in commoditising the expertise of the existing labour force. This labour force is uniquely positioned with experience in developing, testing and innovating new technologies in direct connection with front-line units to an extent that is incomparable with many other nations.¹⁵ The conflict with Russia has highlighted global deficiencies in digital skills, and the respective subsectors within it, whereas Ukraine retains an active advantage in this space.

Another competitive positioning factor relating to labour is the absence of restrictions to entering the defence labour force. Comparable challenges in many other defence-industrial bases could include security clearance requirements which constrain workforce supply. This relative flexibility has enabled Ukraine to maximise the utility of the resources that are available to it¹⁶ – an example of one of the ways the defence sector is taking advantage of the wider freedom of manoeuvre provided by its wartime footing. Ukraine’s relatively high levels of overall societal resilience further augment this, enabling the fielding of a workforce with high levels of alignment to the overall defence industry mission.¹⁷

Access to capital

Ukrainian defence has benefitted from the support of allies and partners through aid in

the form of military equipment and investment, but as the conflict continues ongoing access to capital becomes an urgent policy priority. Access to domestic capital, through credit and reliance on internal funds, has been restricted and hampered growth in the years leading up to the war. Access to capital from the global private sector is hindered by perceptions of an unfavourable investment climate. Perceptions of corruption and unclear business practice continue to dissuade investment.¹⁸ Pressure for institutional reform has been supported by international organisations, such as the World Bank, who have also reported a need for more stable macroeconomic policies.¹⁹ This lack of trust, in part, comes from insufficient protection to rights of ownership and intellectual property for foreign investors, necessitating judicial reform, as well as prior experiences of corruption and also cumbersome administrative obstacles.²⁰ Numerous reforms have been enacted since 2014 to improve the situation, including the creation of anti-corruption bodies, but a 2020 rollback in provisions to those bodies has been seen as a reversal and has reduced their impact.²¹ In 2023, the Ukrainian parliament approved amendments to Bill No.8138, the Law on State Support for Significant Investments, which accounted for compensation for the costs associated with connecting to existing utility, engineering and transport networks, reduced employment criteria associated with new investments, and reduced the target

14 Dnipropetrovsk Investment Agency (2023); Coniglio et al. (2024).

15 SME interview by authors, 14 February 2025, b.

16 Sheludko & Zavgorodnia (2022).

17 SME interview by authors, 14 February 2025, b.

18 International Trade Administration (2023); Dombrovska (2025).

19 Dombrovska (2025).

20 Zinchenko (2024).

21 International Trade Administration (2023).

investment requirements.²² However, the pre-existing contextual obstacles mentioned above have been compounded by the war, which has destabilised the market and made it difficult to provide safety guarantees to investors.

Whilst Ukraine continues to attract industrial aid funding, a decline in FDI continues to inhibit long-term growth prospects for Ukraine. The lack of FDI is making it difficult for Ukraine to overcome the current misalignment between the purchasing power of the state and the production capability of its domestic defence industry.²³ This compounds feelings of uncertainty amongst private firms that are emerging to meet state demand.²⁴ One expert interviewee noted that the structure of Ukrainian defence procurement may be a barrier to improving trust.²⁵ The highly decentralised procurement base, largely made up of small and medium-sized entities, presents a challenge to international investors attuned to working with global primes. Ukraine's existing structure has many advantages in terms of fostering competition and innovation, and it has already demonstrated substantial proficiency in integrating smaller private sector entities. However, in an already unfavourable investment climate, investment from larger, prime contractors is held back by perceptions of a lack of a peer to work with to build a basis of trust.²⁶

International aid has been essential for maintaining Ukraine's warfighting capabilities.

However, experts have suggested that an influx of defence equipment can reduce the productivity of the domestic defence industry, and in turn generate a complex and convoluted supply chain and sustainment challenge.²⁷ Responses to near-term, in-theatre demands are essential, but they shouldn't be segregated from longer-term industrial planning – it is important to establish some fluidity between the two that will enable Ukraine to make the best use of the investment that it is able to secure.²⁸

The Danish strategy of providing aid to Ukraine has focused on investing in its defence economy, providing it with capital, as well as equipment. Other aid packages could be agreed in the same way that the Danish Ministry of Defence has financed arms procurement projects from Ukrainian manufacturers, to help realign industrial production capabilities and available spending. Ukraine can continue to prepare lists of projects that need funding, and national governments can examine their track records and capabilities and agree on where to invest.²⁹ The same approach could also be extended to private entities, who can work in cooperation with their governments to access data on smaller companies they might be keen to invest in. Using international aid to finance domestic procurement comes with several advantages: it sustains and grows expertise in development and production; it enhances the long-term viability of wartime

22 UkraineInvest (2023).

23 Milakovsky & Vlasiuk (2024).

24 Milakovsky & Vlasiuk (2024).

25 SME interview by the authors, 26 February 2025, a.

26 SME interview by the authors, 14 March 2025.

27 SME interview by the authors, 14 March 2025.

28 SME interview by the authors, 14 March 2025.

29 Ministry of Defence of Ukraine (2025).

procurement solutions; and it can mean faster delivery times, testing and training.³⁰

Innovation

Innovation has emerged as a significant strength for Ukraine. Indeed, innovation has been a necessity for the country, in order to find ways to exceed limits in how much it can produce, to meet front-line demands in short time frames, and to address the tactical implications of fighting an adversary that can draw on significant and sustained industrial mass.³¹ Harnessing this innovative capacity moving forward will be key for Ukraine's long-term defence-industrial prospects.

The commoditisation of this unique source of strategic, tactical and technical knowledge will be a core facet of Ukraine's long-term defence-industrial development. Some of the conditions in which these qualities have developed are dependent on the war itself. Testing adaptations to equipment in the field, for example, has been possible due to close relationships between units and industrial producers. The same can be said for the lack of restrictions imposed by governance and regulation, a situation which facilitates a very creative and fast-paced approach to research and development that could not operate in the same way during peacetime.³² Other conditions are potentially culturally embedded. Interviewed experts noted the importance of the mindset that has oriented the Ukrainian effort to quickly learn how to integrate vast amounts of technology of varied origins, as well as to develop their own

variants from dual-use technologies. This has enabled Ukraine to match its more militarily powerful adversary.³³ Sustaining this model outside of conflict, however, will come with challenges. Possible mechanisms to drive retention of this capability include wargaming, training according to lessons learned, and the generation of insights about the Russian adversary being sold as a service. Also essential for the preservation of these skills, is creating a defence-industrial base that can enable Ukraine to return investment into the economy, and that can absorb the increased proportion of the population that has remained unskilled since the outbreak of war.³⁴

Demand conditions

Domestic demand

Domestic demand is the most significant driver of Ukraine's defence-industrial production base. In 2022, at beginning of the Russian invasion, Ukraine's defence industry had an overall capacity of \$1 billion; the Atlantic Council has reported that its capacity is expected to reach a high of \$35 billion dollars in 2025.³⁵ This is driven by unprecedented defence spending of up to 37 per cent of GDP, a proportion of national budget that will be unsustainable in the long term. As Russian military operations continue, there will continue to be demand for products, particularly in the UAS segment, though prospects for generation of an external export market are more complex. The domestic industrial base is currently producing around a third of the weapons and ammunition

30 Ministry of Defence of Ukraine (2025).

31 SME interview by the authors, 14 February 2025, a; SME interview by the authors, 26 February 2025, a.

32 SME interview by the authors, 26 February 2025, a.

33 SME interview by the authors, 26 February 2025, a.

34 SME interview by the authors, 25 February 2025, a.

35 Kuzan (2025).

being used by the Ukrainian Armed Forces, while in the UAS segment this proportion is estimated to be substantively higher and approaching 100 per cent. Domestic demand is therefore a strong and consistent driver of investment and capability development in the underlying Ukrainian UAS production landscape. One aspect of Ukraine's response to surging domestic demand raised in interviews has been a high level of sourcing flexibility, extending to the procurement of 'off-the-shelf' components, including from China. In the longer term, this may generate a level of supply chain dependency and complexity from which it is necessary to unwind in order to generate export market share, given the likely focus of export partners and industrial collaborators on surety and security of supply.

International demand

Whilst domestic demand is strong, Ukraine currently faces challenges in converting this into international competitiveness. Ukrainian defence production in UAS and adjacent sectors is currently largely oriented to the specific operational needs of the Ukrainian Armed Forces, though the country does have a defence exports track record in peacetime. In the longer term, a successful exports strategy for UAS will rely on shaping output design to the needs to recipient's markets and aligning to the relatively increased regulatory barriers of target markets.

The Russian invasion has prompted major changes in European defence plans, in terms of both the aid supplied to Ukraine and the most recent plans announced for European rearmament. However, at present, European procurement is fragmented. The Ukrainian Armed Forces have integrated the vast array

of military technology supplied by Europe as successfully as possible, despite their limited interoperability.³⁶ This limited interoperability is, however, a reflection of a wider mismatch in demand signals and procurement processes. Ukraine's inclusion in the €150 billion collective funding arrangement under the ReArm Europe plan developed by the European Union does generate prospects of closer Ukrainian alignment to European defence acquisition. Whilst Ukraine's conflict experience has shaped international understanding of modern conflict, demand for Ukrainian equipment is still not forthcoming.

Ukraine's ability to supply markets will also change in the international context. The current production of equipment at a rapid rate, and for a low cost, is largely a product of Ukraine's wartime footing. The urgent nature of demand means that layers of governance, safety regulations and testing have been stripped back.³⁷ A longer-term export orientation will require these factors to be addressed.

Strategy, structure and rivalry

Ukraine's clear focus on defence-industrial development in UAS is bearing fruit. An influx of tech-oriented start-ups as well as the integration of private companies into national defence production are driving surging output. Ongoing investment from international partners will generate further development of Ukraine's defence output in UAS and adjacent sectors, so long as it is geared towards domestic production in Ukraine along the lines of, for example, the Danish model. Ukraine's strong top-down strategic focus on the development of a defence-industrial base and competitive advantage in UAS and adjacent sectors is a powerful policy instrument. In the

36 Bergmann (2024).

37 SME interview by the authors, 26 February 2025, a.

coming years, prospects are significant for myriad international actors to seek a role in the burgeoning international export market for UAS systems and products, with Türkiye and the Republic of Korea already developing significant and mature product offerings, and a range of products being developed by well-capitalised actors such as Helsing and Anduril from the United States and Europe beginning to capture market share. To that end, Ukraine's focus on domestic operational requirements and relatively low levels of regulatory compliance are likely to inhibit the capture and sustainment of market share for export in the medium to longer term, despite advantageous workforce and price factors. Ukraine's substantial advantages in innovative capacity and its operational experience of warfighting and real-time product iteration, however, combined with a high level of alignment between government strategy and industrial base, are core drivers of advantage that should be capitalised upon.

Recommendations

Ukraine's UAS and adjacent defence-industrial production is delivering success in terms of Ukraine's current operational requirements and demand signal. This demand signal is driven by the extraordinary defence spending that Russia's full-scale invasion has necessitated since 2022, combined with the specific requirements of a relatively static modality of conflict. Ukraine has marshalled its underlying production factors to significant effect and made use of common-sense simplifications and streamlined procedures to ramp-up production in this extraordinary context, but the same factors will not drive a sustainable long-term defence-industrial footprint buoyed by export business. The primary drivers of advantage in Ukraine's UAS defence-industrial footprint are its innovative

capacity and its ability to leverage a highly skilled and experienced workforce and a societal resilience mindset to augment the fast-turn needs of production in vanguard technologies. Competitors, meanwhile, are gaining a significant international foothold in the complex, high-end UAS segment based on product and price differentiation, and are obtaining an embedded advantage that Ukraine may be hard-pressed to overturn. Instead, Ukraine can focus on competing at the integration level, rather than based on product. This model of competition would see Ukraine focusing on exporting its unique skills as a service offering, integrating with defence-industrial production ramp-up efforts across Europe directly through the provision of know-how and advanced skills, rather than seeking to compete based on product. This high-level strategic recommendation is augmented by the following specific recommendations for Ukraine to focus its near-term efforts on:

Designing measures to support the retention of unique skills. Establishing a strategy for the retention of tactical, strategic, technological and innovation process know-how acquired during the current conflict will augment Ukraine's long-term defence-industrial position fundamentally.

Designing a strategy for the commoditisation of unique skills. Ukraine's market advantage is primarily in its experience and its capacity for integration and innovation. It should aspire to retain those skills and commoditise them as a packaged service offering to support allied defence collaboration efforts through a centralised initiative such as Brave1.

Driving industrial localisation. Ukraine is already benefitting from the presence of a decentralised industrial base. Further localisation of production would augment this strategy, ensuring continuity in

production and procurement programmes.³⁸ It would additionally aid in continuing Ukraine's quick response to changes on the battlefield by reducing threats to its ability to replenish arsenals.³⁹

Investing in domestic defence production.

Whilst overseas aid has sustained Ukraine's ability to stay in the fight, its longer-term security will be delivered through streamlined domestic production. Through targeted industrial participation efforts this can be partially achieved via imports.

Increasing efforts to redirect civilian industry towards defence production. Greater incorporation of civilian industries in weapons production will help to increase output quantity, as will the inclusion of more components of the civilian high-tech sector, such as IT companies and UAV manufacturers.⁴⁰ These measures come at a medium-term opportunity cost to

innovation, however, which should be carefully managed as Ukraine transitions away from its current war economy footing.

Continuing to expand state support for military research and development through collaborative innovation with foreign producers.⁴¹

This would help to reduce the cost of research and development (R&D) for smaller, private companies, whilst speeding up the process.⁴² It would encourage long-term collaborative relationships that demonstrate the unique capabilities that Ukraine has to offer.

Continuing to broaden the scope of the 'Danish Model' for procurement into other international partnerships. This would begin to solve the main obstacle hindering the expansion of domestic production – a shortage of capital – whilst providing a measure of surety for external investors and sustaining Ukrainian domestic demand.

38 Zhelikhovskiy (2024).

39 Zhelikhovskiy (2024).

40 Zhelikhovskiy (2024).

41 Milakovskiy & Vlasjuk (2024).

42 Milakovskiy & Vlasjuk (2024).

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Annex. Drone producers in Ukraine

Table 1. Drone producers in Ukraine

| Company | Product | Comments and observations |
|---------------------------|--|--|
| Vyriy | Molfar | One of the largest First Person View (FPV) drone manufacturers Small, cheap model in use since beginning of 2023 Working to onshore production sites Dependent on Chinese components |
| Skyfall | Vampire, Shrike | Low profile but has increased production output to a large scale since June 2022 Producing some of the cheapest quadcopters being purchased en masse inside of Ukraine |
| TAF | Kolibry 7, 8, and 10-inch FPV quadcopters | One of the largest-scale manufacturers of FPV drones in Ukraine – producing approximately 40,000 per month, with an output valued at over \$1 billion/year Surged production significantly in the last year Supplied approximately 1/3 of the drones shipped to the front line in 2024 |
| UkrSpecSystems | Shark and PD 2 | The 'archetypal Ukrainian drone maker' Producing since 2014 |
| UkrJet | UJ 22 and UJ 26 (Bober/Beaver) | A core player in the wartime drone boom |
| Terminal Autonomy | AQ 100 'Bayone', AQ 400 'Scythe' | Low-profile, international firm, but Ukraine-based Ships over 1,000 AQ 100s per month Produces the cheapest long-distance strike drones |
| Antonov | AN-196 Lyuty | Largest traditional aircraft maker in Ukraine Previously government-owned, transitioned into a private holding in 2024 but has well-established ties in the state-owned defence conglomerate |
| Airlogix | GOR/ISR | Large-scale manufacturer, militarised production after the Russian invasion Quintupled sales of the GOR in 2024 |
| Aliand Systems | Autonomous drones for remote mine detection | Start-up focused on developing an AI technology that can be used for swarming Has raised \$2.7 million in investment |
| Neros Technologies | Archer | Highest supply rate for any US drone producer – contracted at 6,000 FPV attack drones |

Source: Bilousova et al. (2024); Post (2025)

Abbreviations

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|-----|--|
| FDI | Foreign Direct Investment |
| FPV | First-Person View |
| GDP | Gross Domestic Product |
| ISR | Intelligence, Surveillance & Reconnaissance |
| IT | Information Technology |
| MDT | Ministry of Digital Transformation (Ukraine) |
| R&D | Research & Development |
| SME | Subject Matter Expert |
| UAS | Unmanned Aerial System |
| UAV | Unmanned Aerial Vehicle |
| UUV | Uncrewed Underwater Vehicle |