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Progress by innovation

Ukraine's Current & Prospective Connections in Strategic Industries

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This report contributes to UNIDO’s work on digital transformation, artificial intelligence, and innovation ecosystems and was prepared under the overall guidance of the UNIDO Division of Digital Transformation and Artificial Intelligence (TCS/DAI). The Division promotes digital transformation and Artificial Intelligence, as well as associated technologies, as part of innovation ecosystems encompassing productive capacities in manufacturing, services, and digital firms, with the aim of advancing the competitiveness of industries and manufacturing firms in Member States. It supports industries in benefiting from the rapid progress in digital and convergent technologies associated with the Fourth Industrial Revolution (4IR), ensuring a smooth transition towards safe and secure cyber-physical industrial systems and a smart society, while mitigating any potential adverse effects on employment and the quality of work. Through its services, the Division supports productive transformation by integrating industrial businesses, dynamic entrepreneurship, and acceleration mechanisms, and by applying technological innovation to sectors such as smart manufacturing, smart energy, and smart agribusiness, particularly in developing, transition, and emerging economies.

This report has been prepared by **Mr. Pierre-Alexandre Balland** from the Centre for European Policy Studies (CEPS) under the overall guidance of **Mr. Nikolaus Martys**, Industrial Development Expert, UNIDO.

The publication represents a collaborative effort and has benefited from valuable inputs from both UNIDIO and CEPS colleagues. In particular, we would like to thank **Mr. Tomoyoshi Koume**, **Mr. Andrea Renda, Mr. Andrii Zablovskyi** and **Mr. Oleksandr Soshnikov** for their substantive contributions and technical reviews that supported the refinement and finalisation of the report.

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Executive Summary

This report maps Ukraine's current and prospective connections across 25 strategic industries using three complementary data sources: bilateral trade flows (UN COMTRADE), research co-publication networks (OpenAlex), and patent co-invention data (OECD REGPAT). Together, these layers provide a comprehensive picture of where Ukraine's economic and technological relationships are already substantial and where the most consequential opportunities for deepening remain.

The analysis develops six headline findings that have implications for industrial strategy and the road to Ukraine's accession to the EU.

Overall, Ukraine is found to be deeply embedded in the European industrial, technological, and scientific ecosystem, but its strategic potential is being systematically underleveraged.

1 EUROPEAN INTEGRATION IS ALREADY A STRUCTURAL REALITY

The European Union collectively accounts for 62.5% of Ukraine's imports and 63% of its exports in key strategic industries. This degree of integration is not recent, predating as it does the full-scale invasion, and it holds across trade, scientific collaboration, and, to some extent, technology networks. The central policy challenge is how to deepen and diversify that integration beyond proximate partner countries (EU13 countries).

2 THE EXPORT BASE IS STRUCTURALLY NARROW AND CONCENTRATED IN LOW-COMPLEXITY SECTORS

Mining alone accounts for 48.8% of Ukrainian exports in strategic industries, and the next four largest export categories - chemical engineering, wood processing, metallurgy, and textiles - are strongly resource-based, low-value-added activities. Together, these five sectors represent 77.7% of total exports in the key strategic industries. This structure predates the war, which reinforced it by destroying higher-value manufacturing capacity and disrupting advanced supply chains.

3 CHINA REPRESENTS A STRUCTURAL SUPPLY NODE THAT DEMANDS STRATEGIC ATTENTION

China accounts for 13.6% of Ukrainian imports overall and 17.5% of exports - a large connection concentrated in sectors of strategic sensitivity. In unmanned and autonomous systems (UAS), the Chinese import share reaches 71.1%, which is an important finding in this analysis for a country relying on drone technology as a core military capability. Reducing this dependency through deliberate reconstruction investment and EU-aligned supply chain development is a strategic imperative.

4 THE AGRITECH PARADOX REVEALS A CLEAR VALUE-CHAIN OPPORTUNITY

Ukraine is one of the world's largest agricultural exporters yet imports 2.77 billion U.S. dollars in agricultural technology against just 78 million U.S. dollars in exports. The country generates enormous downstream agricultural export value while capturing almost none of the upstream technology value chain. Reconstruction investment in agricultural machinery, precision farming, and artificial intelligence (AI)-enabled agritech manufacturing could leverage Ukraine's existing engineering base and its unmatched scale as an end-user and test market. This represents one of the clearest opportunities to convert an existing comparative advantage into a higher-complexity industrial position aligned with EU accession.

5 UKRAINE'S SCIENTIFIC NETWORKS ARE BROAD AND WESTERN-ORIENTED BUT ITS COMMERCIAL TECHNOLOGY RECORD IS THIN

Research collaboration data show Ukraine engaged across 25 strategic sectors with a network anchored in Central and Eastern Europe - Poland, Slovakia, Czechia, and the Baltic states - with meaningful reach into Germany, the UK and the US. This scientific base is real and substantial. Patent co-invention data tell a different story: across virtually every sector, Ukraine's commercial technology partnerships are thin, and dramatically underweight relative to those of global innovation leaders. Converting strong research networks into joint commercial invention is one of the most important medium-term industrial policy challenges.

6 ENERGY RECONSTRUCTION IS THE HIGHEST-RETURN INVESTMENT

At 9.3 billion U.S. dollars, energy is Ukraine's largest import category in key strategic industries. This is a direct consequence of systematic Russian attacks on generation and transmission infrastructure. Rebuilding nuclear capacity, reconstructing the grid, and expanding renewable generation in western Ukraine would simultaneously eliminate the largest import line, restore export revenue to EU neighbours, and build the infrastructure profile that EU accession requires. No other reconstruction investment aligns donor, recipient, and accession interests as completely. This is also critical in the transition to an Artificial Intelligence (AI)-first economy.

1

Introduction

The economic and technological dimensions of Ukraine’s position, including its trade relationships, its scientific networks, its innovation capacity - are crucial for understanding both the stakes of the conflict and the foundations on which recovery and reconstruction must be built.

The war in Ukraine understandably dominates attention with its urgent military imperatives and severe humanitarian consequences. Yet the economic and technological dimensions of Ukraine's position, including its trade relationships, its scientific networks, and its innovation capacity, are crucial for understanding both the stakes of the armed conflict and the foundations on which post-war reconstruction must be built. A country's strategic importance is not determined by geography and natural resources alone; it is shaped by the complexity and density of its integration into global production, knowledge, and technology systems.

This report provides a systematic, data-driven mapping of Ukraine's current and prospective strategic connections across 25 industries identified as critical for Ukraine's reconstruction and EU accession trajectory.

These industries span four broad domains: core resource sectors (mining, coal, metallurgy, chemical engineering, wood processing); defence and security technology (defencetech, UAS, aerospace); advanced manufacturing (automotive, textiles, shipbuilding, railway, robotics); and enabling digital and civic infrastructure (energy, greentech, semiconductors, biotech, medtech, agritech, AI, edtech, govtech, extended reality, secure cyberspace, nuclear).

Bilateral trade flows from UN COMTRADE provide the most direct measure of commercial integration and competitive positioning. Research co-publication networks from OpenAlex capture the scientific foundation on which future technological capacity is built. Patent co-invention data from the OECD REGPAT database reveals where formal commercial technology partnerships have matured.

Together, these layers generate a picture that is simultaneously more encouraging and more alarming than conventional accounts suggest: encouraging because Ukraine is already deeply embedded in European trade and scientific systems to a degree that is not always widely appreciated; and alarming because the gap between research capacity and commercial technology output is high. This is because critical import dependencies – in particular on China in defence-adjacent sectors – are strategically challenging, and because the export base remains overwhelmingly concentrated in raw and semi-processed commodities rather than the complex manufactured goods and knowledge-intensive services on which sustainable development trajectories are built.

The analysis is grounded in three complementary data layers that capture distinct but interrelated dimensions of economic and technological activity.

The overall picture is of a country whose strategic potential is being systematically underleveraged, and whose reconstruction presents a time-bounded opportunity to change that.

The report is structured as follows: section 2 describes the data sources and methodology; section 3 presents the trade analysis, both at the aggregate level and across the most strategically significant individual sectors; section 4 analyses scientific collaboration networks; section 5 examines patent co-invention patterns; section 6 draws synthetic conclusions across all three data layers; and section 7 sets out policy recommendations.

2

Data and Methods

Trade data captures the commercial scale and direction of Ukraine's integration into global production networks and enables calculation of indicators that measure whether Ukraine is a competitively positioned supplier to specific markets.

2.1 DATA SOURCES

The analysis draws on three complementary data sources from between 2020 and 2025. Trade flows are sourced from UN COMTRADE and cover bilateral trade in goods classified to a common set of 21 key strategic technologies using the Harmonised System (HS17) 4-digit classification for 2024. Trade data captures the commercial scale and direction of Ukraine's integration into global production networks and enables calculation of indicators that measure whether Ukraine is a competitively positioned supplier to specific markets.

Scientific publications are drawn from the OpenAlex database and span 2021 to 2025. Co-publication links between Ukrainian research institutions and foreign counterparts are mapped to the 25 strategic industries, allowing identification of both actual collaboration intensity and structural gaps relative to expected collaboration given the size and research output of each partner country.

Patent co-invention data are sourced from the OECD REGPAT database and cover 2020-2024. Co-patents provide a measure of joint commercial technology development. This is a higher bar than co-publication, requiring that two or more parties in different countries jointly develop and formally register an invention.

2.2 SECTOR CLASSIFICATION METHODOLOGY

A central methodological challenge is the consistent classification of heterogeneous data (patents described in technical legal language, publications using scientific terminology, and trade products defined by customs codes) into a common set of key strategic industries. To address this, the report employs a three-step hybrid approach combining semantic machine learning, empirical validation, and human-in-the-loop review.

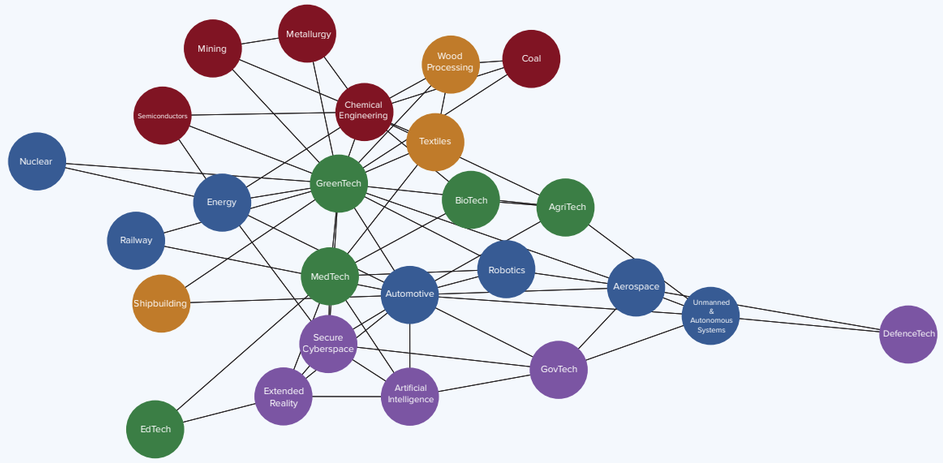
In the first step, descriptive keywords for each strategic sector, together with CPC patent classes, OpenAlex scientific topics, and HS 4-digit trade codes, are embedded into high-dimensional semantic vectors using a large-scale text embedding model. Candidate matches between records and sectors are generated using cosine similarity, enabling the classification to capture semantic equivalence even when different terminologies are used across disciplines, for instance, recognising that additive manufacturing and 3D printing refer to the same technological domain.

In the second step, semantic matches are validated through empirical relatedness (Hidalgo et al., 2007; Balland et al., 2019; Balland et al., 2022), measured by normalised co-occurrences: CPC codes co-appearing on the same patent, topics co-appearing within the same publication, or product codes within the same ecosystems. This step filters out semantically plausible but empirically irrelevant links. In the third step, borderline and ambiguous cases are subject to systematic manual review to define robust classification thresholds and ensure conceptual coherence across the 25 sectors.

The consolidated sector list covers 25 industries drawn from 3 source frameworks: the 7 sectors identified in prior UNIDO analysis (Plantera, F., Griffith, J., Kyosovska, N. 2026), the 14 sectors from the WINWIN strategy, and the 16 key strategic technology priority sectors from previous CEPS work (Renda, Balland, Praas and Grabova, 2024). Exact duplicates are merged, near-identical sectors are consolidated under a single consistent label, and sectors unique to each source are preserved. For the trade analysis, 21 of the 25 sectors are covered, as secure cyberspace, AI, extended reality, and govtech cannot be mapped to existing HS trade product classifications.

Figure 1 shows the degree of relatedness of the 25 strategic industries analysed in this report.

FIGURE 1: Technological relatedness of the 25 strategic industries



Source: *https://www.paballand.com/ceps/unido-2/regpat.html*

2.3 ANALYTICAL FRAMEWORK

Trade analysis draws on bilateral import and export dollar values and shares, and bilateral revealed comparative advantage (RCA) indices, decomposing trade by partner country and sector. RCA values above 1 indicate that Ukraine exports more to a specific country than would have been predicted by chance given the size of the domain and the import basket of the recipient country. The RCA measure is used to distinguish structurally sound trade relationships from volume relationships. Collaboration analysis draws on binary link counts (authors from the same country are not double counted in the same publication) as in Balland et al. (2025), normalised co-occurrence measures, and untapped potential calculations. Untapped potential is defined as the gap between the structurally expected number of collaboration links – based on the size of each country's research output in a given sector – and the observed number of actual links. Large untapped potential indicates that a collaboration relationship is far below the level that size and specialisation would predict, pointing to barriers that are institutional, political, or informational rather than structural. We use the same approach for collaborative patents.

1) 2024 data accessed from https://oec.world/en.

3

Trade Flows: Structure, Dependencies, and Strategic Implications

The aggregate trade picture in strategic industries reveals a country that is already deeply European in its commercial orientation but structurally dependent on low-complexity exports and carrying significant asymmetric import dependencies that constitute strategic vulnerabilities.

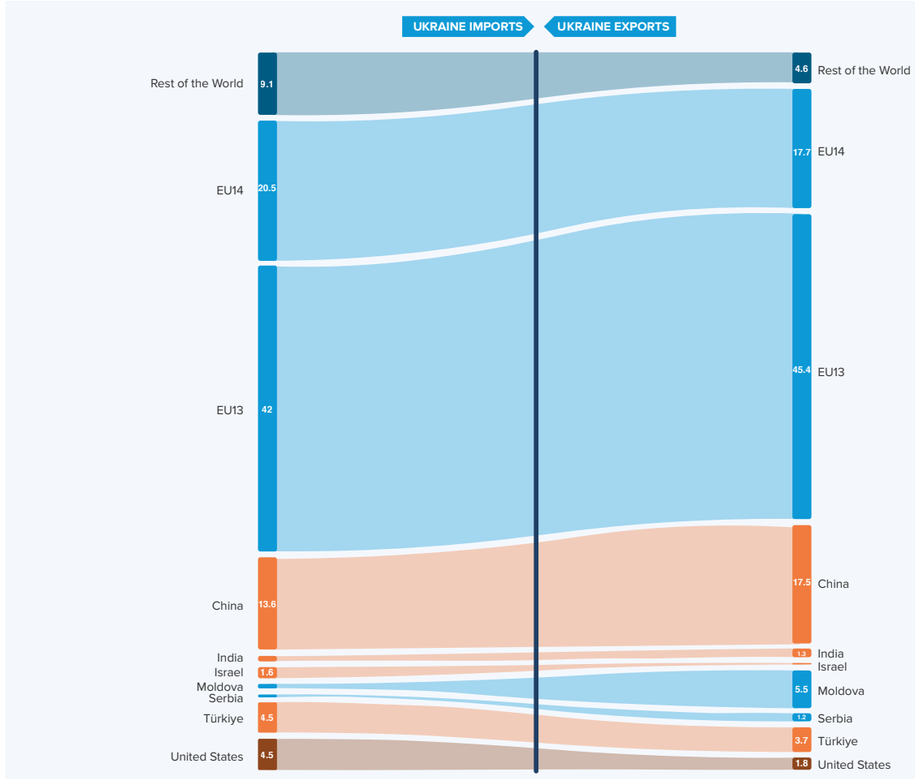
3.1 THE OVERALL ARCHITECTURE OF UKRAINIAN TRADE IN STRATEGIC SECTORS

The aggregate trade picture in strategic industries reveals a country that is already deeply European in its commercial orientation but structurally dependent on low-complexity exports and carrying significant asymmetric import dependencies that constitute strategic vulnerabilities.

At the highest level of aggregation, the EU accounts for approximately 62.5% of Ukraine's imports and 63.1% of its exports across key strategic industries (see Figure 2).

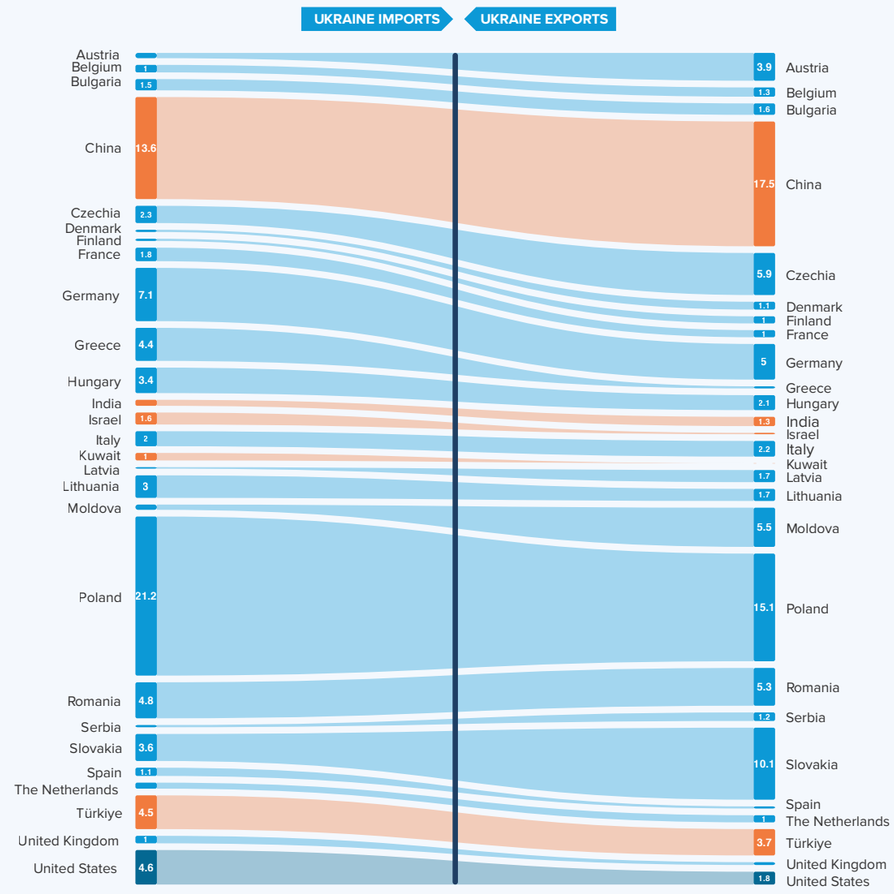
This extraordinary degree of EU integration reflects both the pre-war development of supply chain relationships with Central European manufacturers and the wartime rerouting of trade flows through overland corridors that now predominantly run westward. Ukraine is not merely a potential EU Member State: by the metrics of commercial integration, it is already a de facto member of the European economic space in terms of trade orientation.

FIGURE 2: Imports and exports of Ukraine in strategic Industries (EU countries aggregated)



Within the EU, the relationship is heterogeneous. EU13 countries (the post-2004 accession states of Central and Eastern Europe) account for 42% of imports and 45.4% of exports, substantially outweighing the EU14 (20.5% of imports, 17.7% of exports). This asymmetry reflects geography, infrastructure, and the gravitational pull of pre-war manufacturing integration in the Central European corridor. Poland alone (Figure 3) accounts for 21.2% of imports and 15.1% of exports, which also simultaneously makes Ukraine sensitive to any deterioration in Polish-Ukrainian relations or Polish logistics capacity. Poland alone rivals China as Ukraine's single largest bilateral trade partner. No other country comes close.

FIGURE 3: Imports and exports of Ukraine per country



Source: *https://www.paballand.com/ceps/unido-2/sankey/eu_countries.html*

Germany, at 7.1% of imports and 5% of exports, is the one strong Western EU relationship with symmetry and depth (this reflects stronger industrial integration rather than corridor transit). France, Spain, and most other EU14 members are largely marginal, which somehow narrows the resilience of the Western European relationship to a single anchor.

China's role in the aggregate picture of Ukraine trade flows in strategic industries is central. At 13.6% of imports and 17.5% of exports, China represents a large source of dependency in both ways. What might seem symmetrical is in reality very unbalanced when considering specific industries. It is not just an actual trade issue matter. As will be shown, it might create leverage asymmetries that are particularly consequential in sectors that are directly relevant to Ukraine's military capacity.

The US presents a different kind of paradox. At 4.6% of imports and 1.8% of exports, the commercial relationship between Ukraine and its most consequential military and financial supporter is essentially absent. As this report notes, this matters politically. Without a domestic commercial constituency of American businesses with meaningful stakes in Ukraine's economic trajectory, US political support for Ukraine rests on geopolitical and normative grounds. As recent history demonstrates, these grounds are less durable than commercial interests. Building bilateral economic substance with the US – particularly in sectors where Ukraine has genuine competitive assets – is a policy objective with strategic rationale that goes beyond economics.

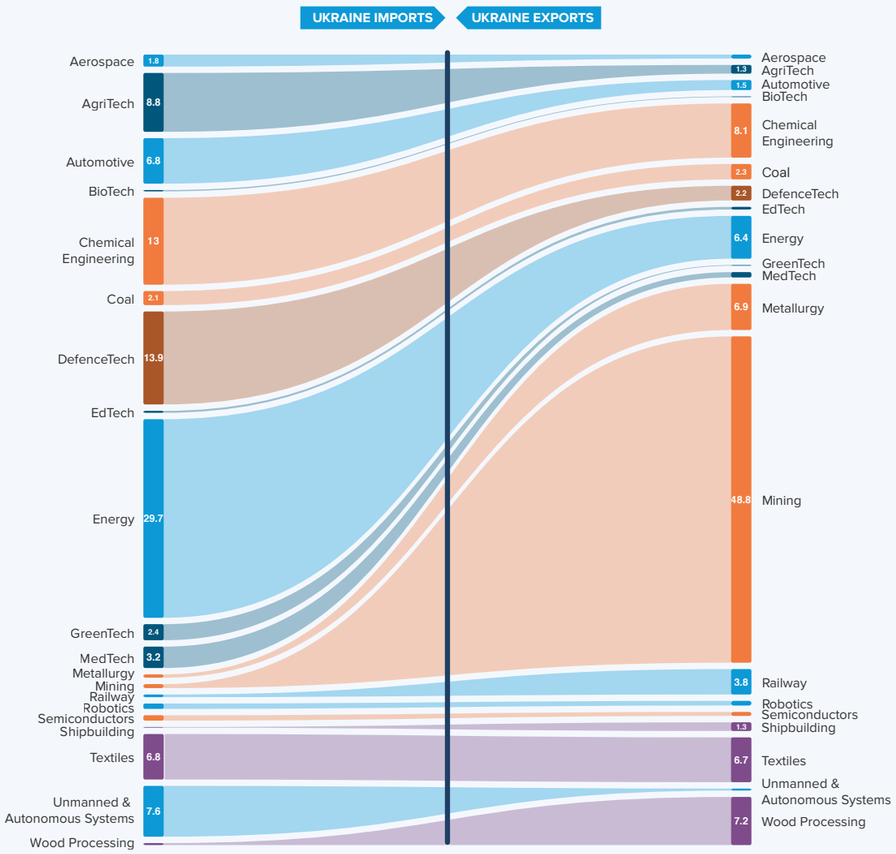
Slovakia's outsize export share of 10.1% and Moldova's at 5.5% is not a reflection of genuine bilateral demand but captures transit and re-export activity through a corridor that has become strategically important since the closure of traditional Black Sea and eastern routes. In the case of Moldova in particular, this creates a concentration risk in a single small transit state whose political stability and infrastructure capacity can be seen as limited.

Türkiye, at 4.5% of imports and 3.7% of exports, reflects a posture of strategic neutrality, where it maintains economic relationships with both Ukraine and Russia simultaneously, and benefits from the supply route gaps created by sanctions and war. India, at roughly 1.6% of imports and 1.3% of exports, represents a striking commercial absence in the dataset: the world's most populous country, a major importer of the agricultural commodities Ukraine produces, has no meaningful trade relationship with Ukraine despite obvious commercial logic on both sides.

3.2 THE EXPORT COMPLEXITY PROBLEM: SECTORAL DECOMPOSITION

The sectoral decomposition of Ukraine's trade is dominated by an observation that is both analytically important and strategically challenging: Ukraine's export base is overwhelmingly concentrated in resource-based, low-complexity sectors (Figure 4).

FIGURE 4: Exports and imports of Ukraine in strategic industries



Source: *https://www.paballand.com/ceps/unido-2/sankey/domains.html*

At 48.8% of exports, mining is the structural anchor of these industries. The next four largest export categories – chemical engineering (8.1%), wood processing (7.2%), metallurgy (6.9%), and textiles (6.7%) – are all resource-proximate industries with limited technological complexity. Together these five sectors account for roughly 78% of total strategic industry exports. This reflects a pre-existing industrial structure that the war has reinforced by destroying higher-value manufacturing capacity and disrupting the supply chains that supply advanced production.

Energy is the single largest import category at 29.7% of imports, or 9.3 billion U.S. dollars in absolute terms. This huge figure is a direct consequence of systematic Russian strikes on Ukrainian power generation and transmission infrastructure. Being such a massive energy importer represents one of the most economically costly dimensions of the war, but also, critically, one of the most recoverable. Reconstruction of energy infrastructure would convert the largest import line into a domestic production item and eventually an export revenue stream.

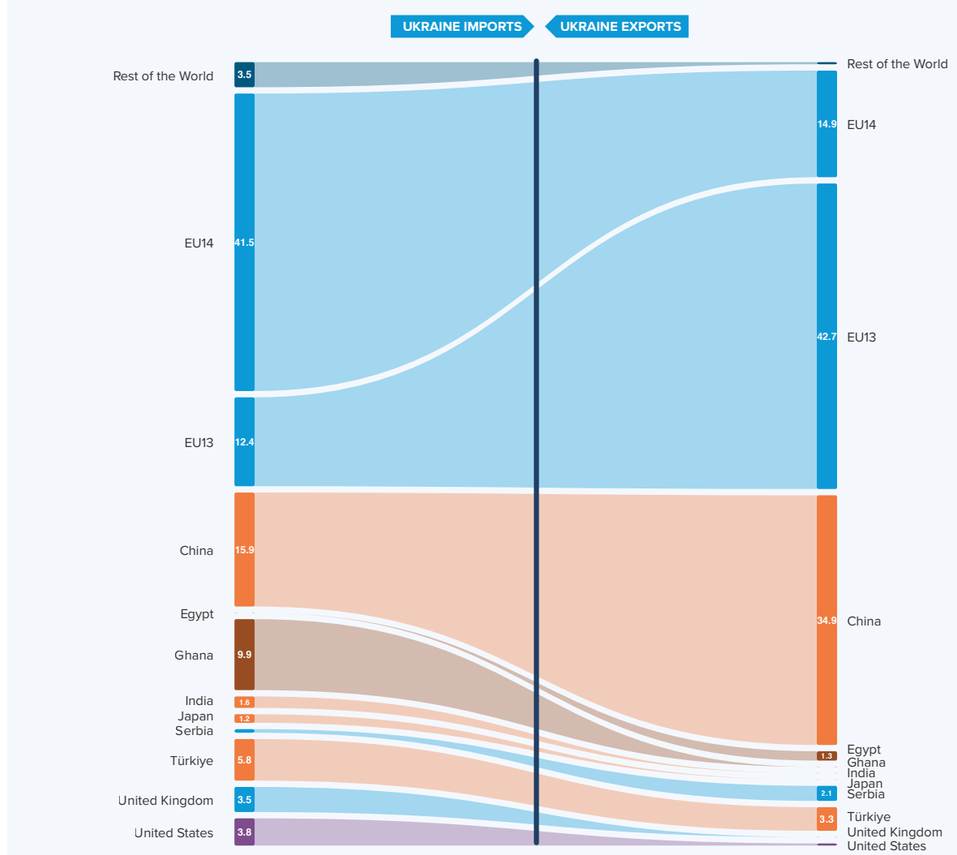
At 13.9% of imports against only 2.2% of exports, defencetech reveals the limits of Ukraine's wartime industrial mobilisation. In absolute terms, Ukraine imports 4.36 billion U.S. dollars in defence technology while exporting 133 million U.S. dollars – a ratio of 33 to 1. The UAS category is even more extreme: 2.3 billion U.S. dollars imported (mainly drones) against 17 million exported.

The technology sectors are revealing in their near absence from the export side. Biotech accounts for 0.1% of exports, greentech for 0.1%, semiconductors for 0.6%, and robotics for 0.7%. Ukraine's well-documented base of software engineers and technical talent (Renda et al., 2025) does not register in goods trade data because that talent has historically been organised around services exports and outsourced development rather than manufactured technology products. This is not a failure of human capital; it is a structural feature of how Ukrainian technology capacity has been commercialised, and it points to an industrial policy gap that EU accession could help address.

3.3 SECTOR-LEVEL ANALYSIS: KEY STRATEGIC FINDINGS

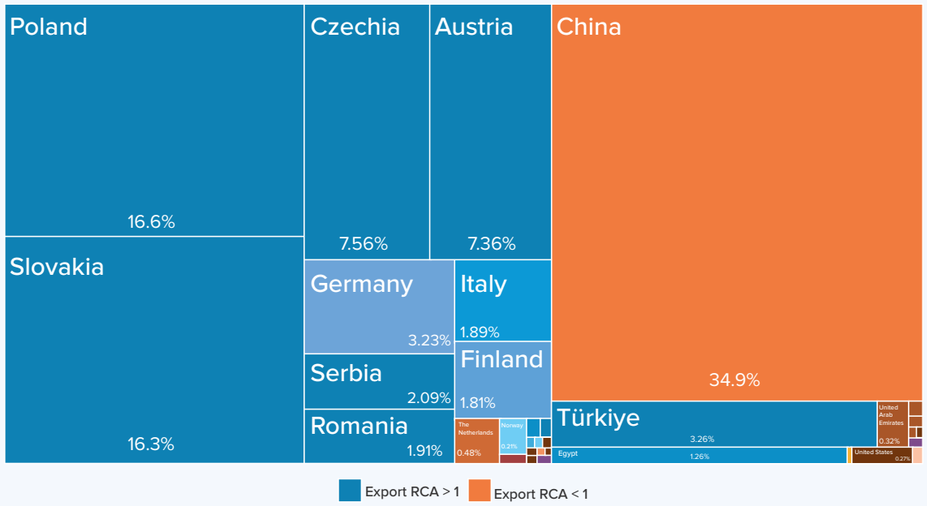
3.3.1 Mining

FIGURE 5: Ukraine trade flows and export destinations in mining



Source: *https://www.paballand.com/ceps/unido-2/sankey/mining.html*

FIGURE 6: Ukraine export destinations in mining



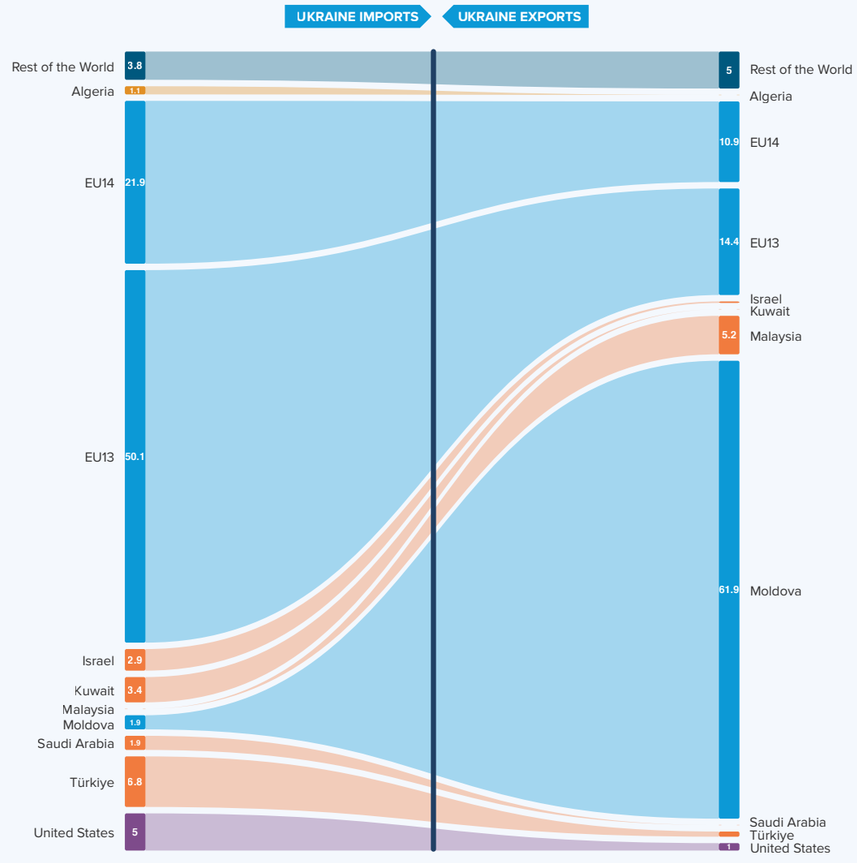
Source: *https://www.paballand.com/ceps/unido-2/sankey/mining.html*

Mining's dominance of Ukrainian exports reflects genuine endowment – Ukraine has extraordinary mineral wealth in iron ore, titanium, lithium, manganese, and a range of critical minerals of increasing strategic importance to the EU's green and digital transitions. But the trade structure reveals a commodity trap rather than a competitive industrial position (Figure 5).

China absorbs 34.9% of mining exports (more than 1 billion U.S. dollars in value, the largest trade relationship here). Yet the RCA for these flows is 0.7, meaning that Ukraine is not a particularly competitive supplier relative to China's global import mix. This is a fragile structural combination: high export concentration in a buyer that can substitute other suppliers with ease. Poland and Slovakia, by contrast, absorb 16.6% and 16.3% respectively with RCA values way above 1. These represent defensible competitive relationships embedded in Central European manufacturing supply chains. The strategic implication is clear: building downstream processing and refining capacity to shift from ore exports to processed and refined industrial inputs would redirect export flows toward markets where Ukraine already has competitive footing and where EU demand is structural and growing.

3.3.2 Energy

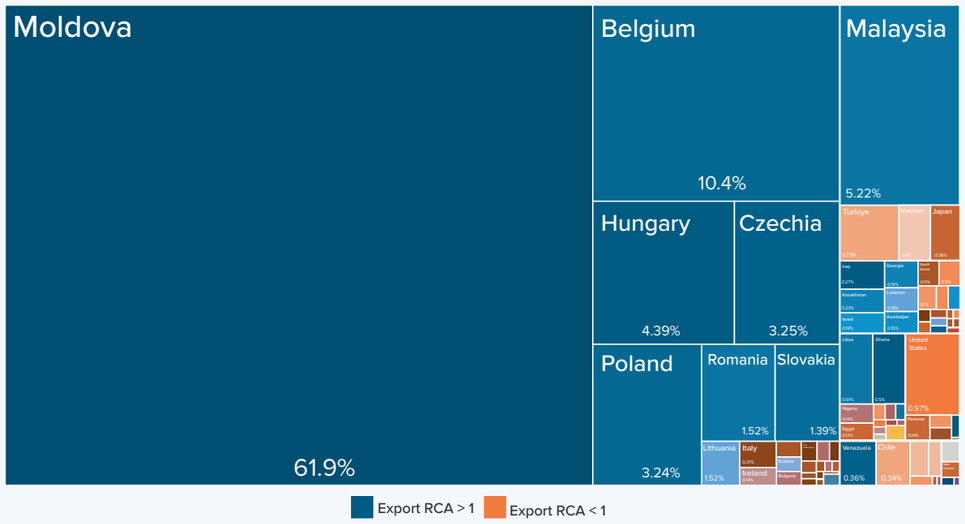
FIGURE 7: Ukraine trade flows and export destinations in energy



Source: *https://www.paballand.com/ceps/unido-2/sankey/energy.html*

To a large extent, energy's status as the largest import category, at 9.3 billion U.S. dollars in 2024, reflects wartime infrastructure destruction but creates a paradoxical policy opportunity. Ukraine and Moldova synchronised with the European ENTSO-E electricity grid in March 2022, creating the physical infrastructure for reintegration with European energy markets. Moldova's receipt of 61.9% of Ukrainian energy exports (240 million U.S. dollars) is not a market relationship but a strategic infrastructure obligation. The accession implication for energy is uniquely constructive. Rebuilding nuclear generation capacity, reconstructing the transmission grid, and expanding renewable generation – in particular solar and wind in western Ukraine – would not only greatly reduce the 9.3 billion U.S. dollars import burden, but also restore EU export capacity via Romania and Slovakia interconnections. It would also build the infrastructure profile that EU membership requires, particularly in relation to growing AI needs. The European Commission has identified Ukrainian energy reconstruction as a strategic priority precisely because donor, recipient, and future Member State interests align more completely here than in any other sector.

FIGURE 8: Ukraine export destinations in energy



Source: *https://www.paballand.com/ceps/unido-2/trade/energy.html*

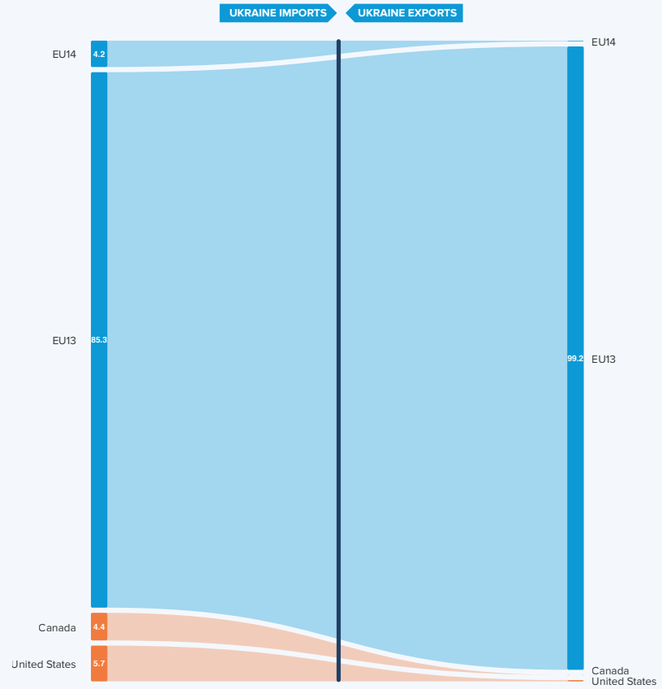
3.3.3 DefenceTech

The defence technology sector import structure reflects wartime supply chain structure: EU13 accounts for 85.3% of imports (3.72 billion U.S. dollars), led by Poland at 2.56 billion, Romania at 719 million, Slovakia at 162 million, and Croatia at 148 million. Many countries are essentially absent as this is the one sector across the entire dataset where Ukrainian supply chain management has explicitly and successfully excluded adversary-linked suppliers.

Romania and Bulgaria dominate exports with RCA values of 26.33 and 28.52 respectively. This points to a specific and currently narrow niche: legacy-compatible ammunition, spare parts, and Soviet-standard components that Western suppliers cannot provide to NATO members still operating inherited Warsaw Pact inventories. This niche is real and commercially significant, but it is not a foundation for a modern defence export industry.

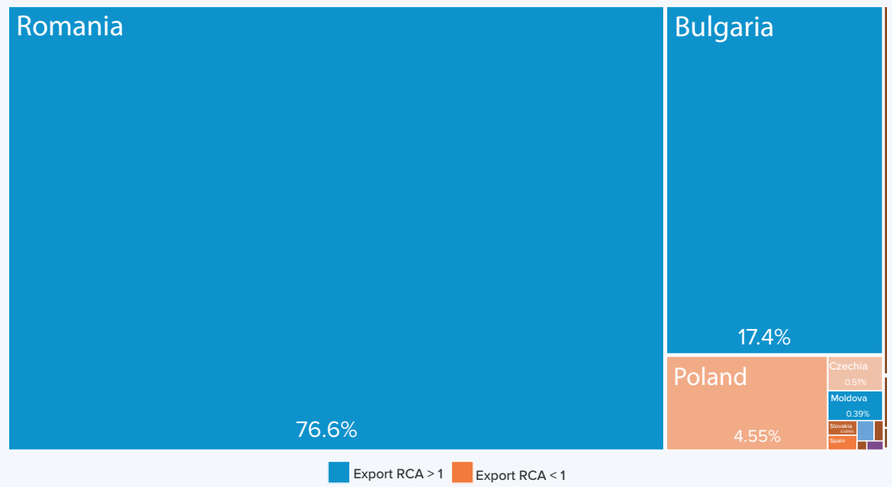
The post-war opportunity is the largest and most time-sensitive in this entire analysis. European rearmament is the defining industrial policy shift of the current decade. NATO members are scaling defence budgets at rates not seen since the Cold War, and every major European defence ministry faces the same structural problem: insufficient domestic production capacity for ammunition, artillery systems, air defence components, and, increasingly, drone and autonomous systems. Ukraine has probably accumulated more live operational experience with these systems than any other country. The window to convert that knowledge into an export-competitive defence industrial base – during reconstruction, before other countries catch up – is relatively short.

FIGURE 9: Ukraine trade flows and export destinations in DefenceTech



Source: *https://www.paballand.com/ceps/unido-2/sankey/defensetech.html*

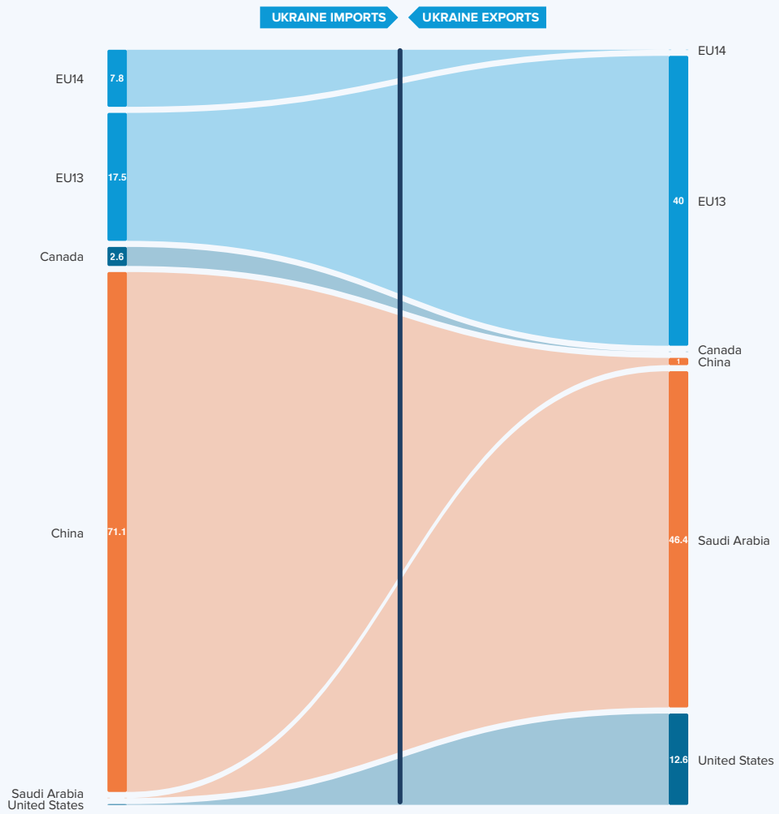
FIGURE 10: Ukraine export destinations in DefenceTech



Source: *https://www.paballand.com/ceps/unido-2/trade/defensetech.html*

3.3.4 Unmanned and autonomous systems

FIGURE 11: Ukraine trade flows in UAS



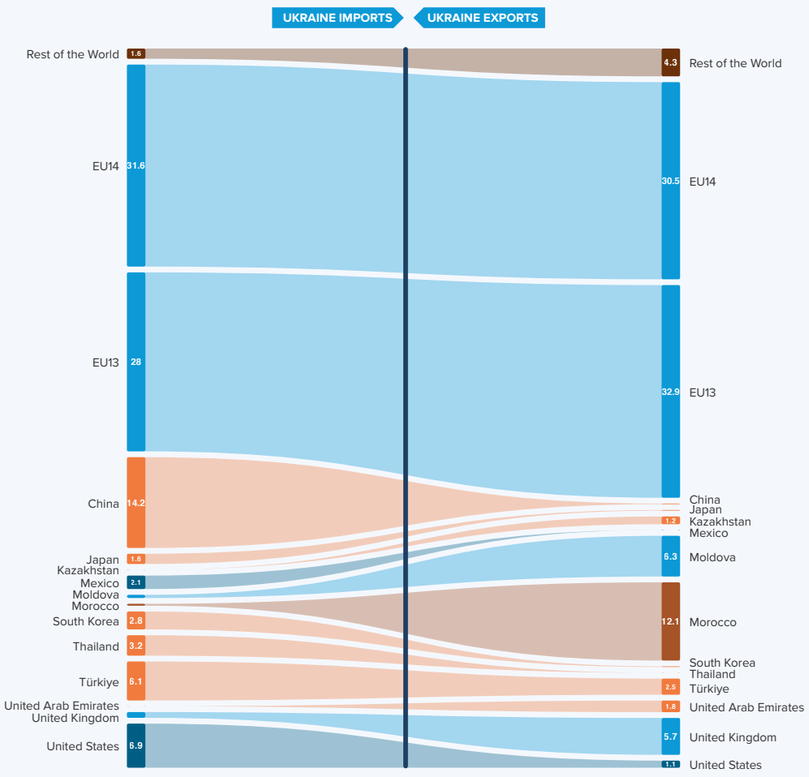
Source: *https://www.paballand.com/ceps/unido-2/sankey/unmanned_autonomous_systems.html*

The UAS (mainly drones) finding demands separate treatment. China at 71.1% of imports (1.08 billion U.S. dollars) is a strategically concerning data point in the trade analysis. Ukraine is building the world's most operationally active drone fleet, in large part from components sourced from a country that has maintained strategic neutrality throughout the war and whose drone manufacturers supply components to both sides of the front line. This dependency is simultaneously militarily and strategically critical. This highlights the need to build European-sourced UAS supply chains during reconstruction. Given the war mobilisation, at 4.87 million U.S. dollars, Ukraine drone exports are negligible.

3.3.5 Automotive

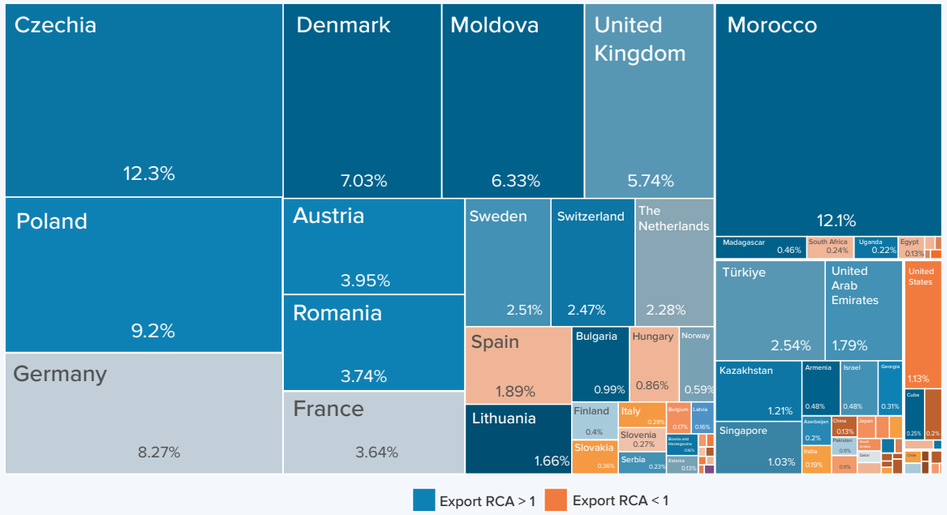
Automotive is structurally one of the most balanced and bidirectional sectors in the analysis. EU14 and EU13 together supply nearly 60% of automotive imports, and (uniquely) EU13 and EU14 are almost perfectly symmetrical on the export side, at 32.9% and 30.5% respectively. This near-parity signals that Ukrainian automotive exports are not purely proximity-driven corridor flows but reflect genuine embedded supplier relationships with manufacturers across both Western and Eastern Europe. The broader electric vehicle (EV) transition, creating new demand for component categories in which labour-cost-competitive EU-adjacent manufacturing has structural advantages, reinforces this sector's accession-era potential.

FIGURE 12: Ukraine trade flows in automotive



Source: *https://www.paballand.com/ceps/unido-2/sankey/automotive.html*

FIGURE 13: Ukraine export destinations in automotive

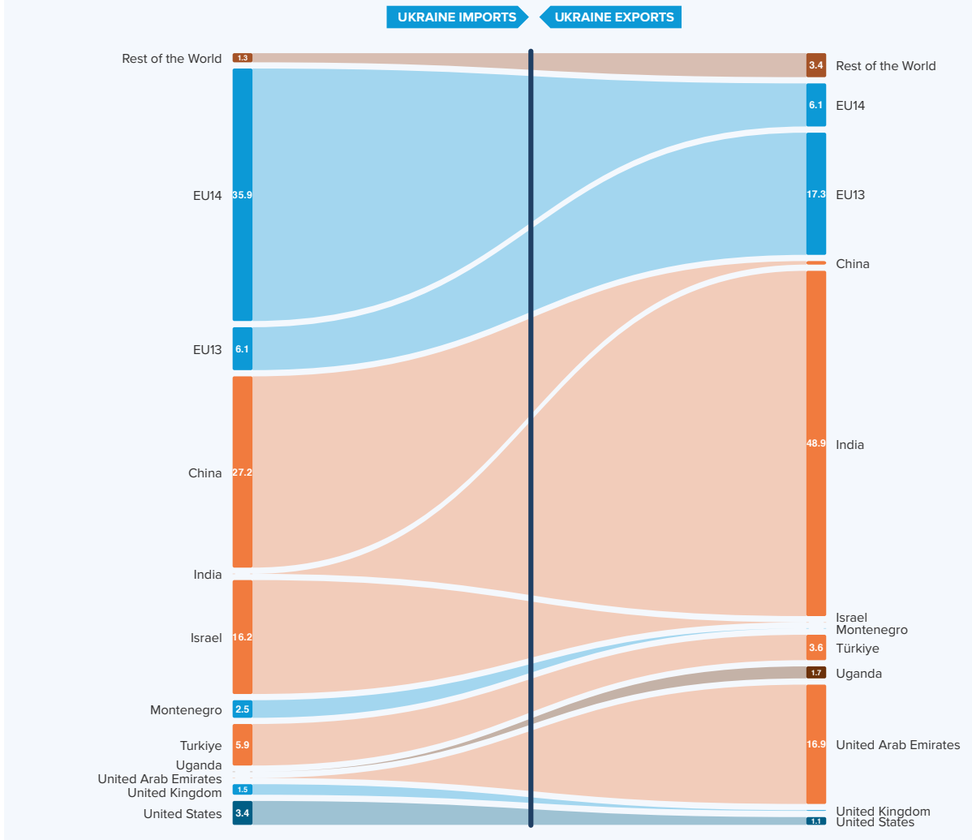


Source: *https://www.paballand.com/ceps/unido-2/trade/automotive.html*

3.3.6 Aerospace

At 34.9 million U.S. dollars, aerospace exports are negligible. India, with 48.9% of exports, source spare aircraft parts, and the UAE, at 16.9%, functions as a global hub for parts brokerage in developing markets. The strategic question is whether Ukraine's genuine engineering depth in aerospace can be redirected towards modern manufacturing – maintenance, repair and overhaul for Western platforms, component manufacturing for Airbus or engine suppliers – before the legacy base disappears. Germany already accounts for 30% of aerospace imports, reflecting meaningful Western supply chain integration on the input side. Poland made this exact institutional and industrial transition over two decades; Ukraine has the human capital to do the same, but the window is not unlimited.

FIGURE 14: Ukraine trade flows in aerospace

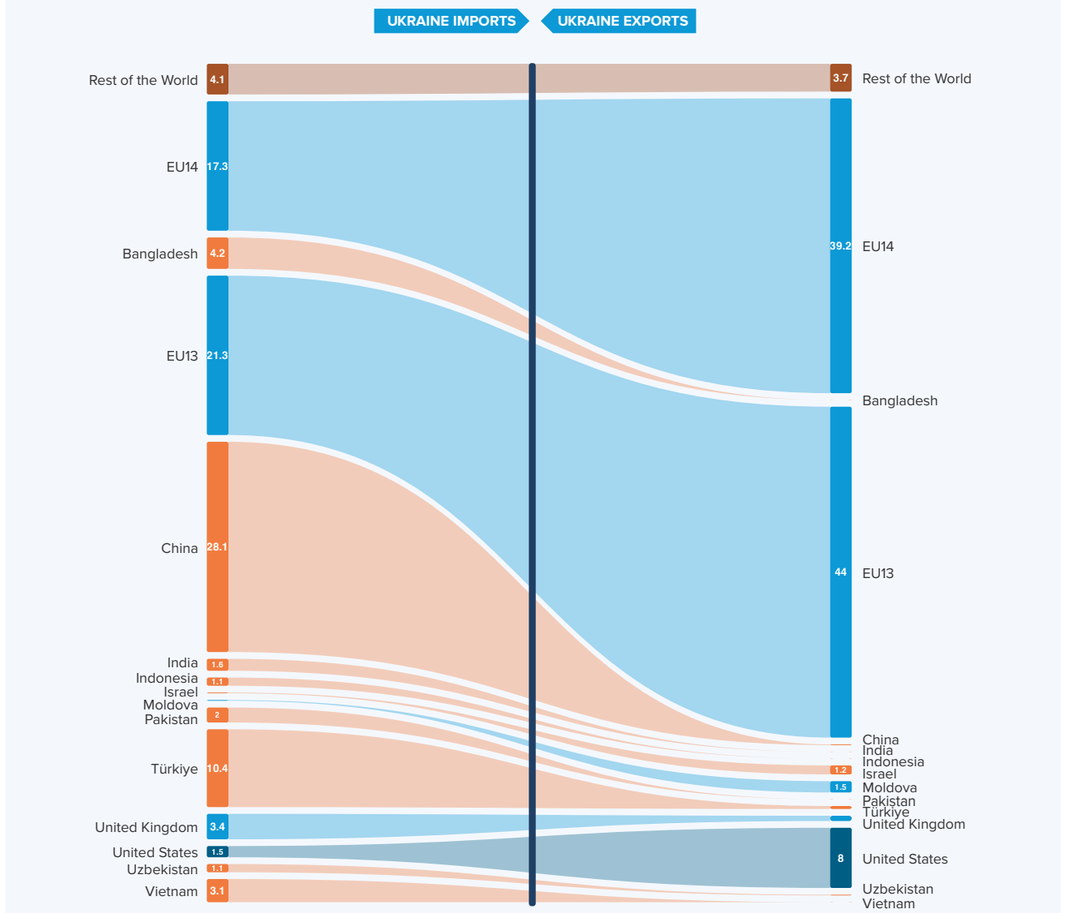


Source: *https://www.paballand.com/ceps/unido-2/sankey/aerospace.html*

3.3.7 Textiles

Textiles is a sector where Ukraine has already achieved substantial EU-oriented export integration. With overall 402 million U.S. dollars in exports in total, EU13 and EU14 together absorb 83.2% of this. This one of the highest EU export concentrations of any sector, and reflects a significant pre-war cut-make-trim manufacturing base that supplied major European fashion and apparel brands. The import side reveals a small dependence on Chinese inputs (28.1% of imports). EU accession would formalise European market access but would also impose EU labour law and chemical regulatory standards that might erode the labour cost advantage and require a value-chain upgrade towards higher-specification technical textiles.

FIGURE 15: Ukraine trade flows in textiles

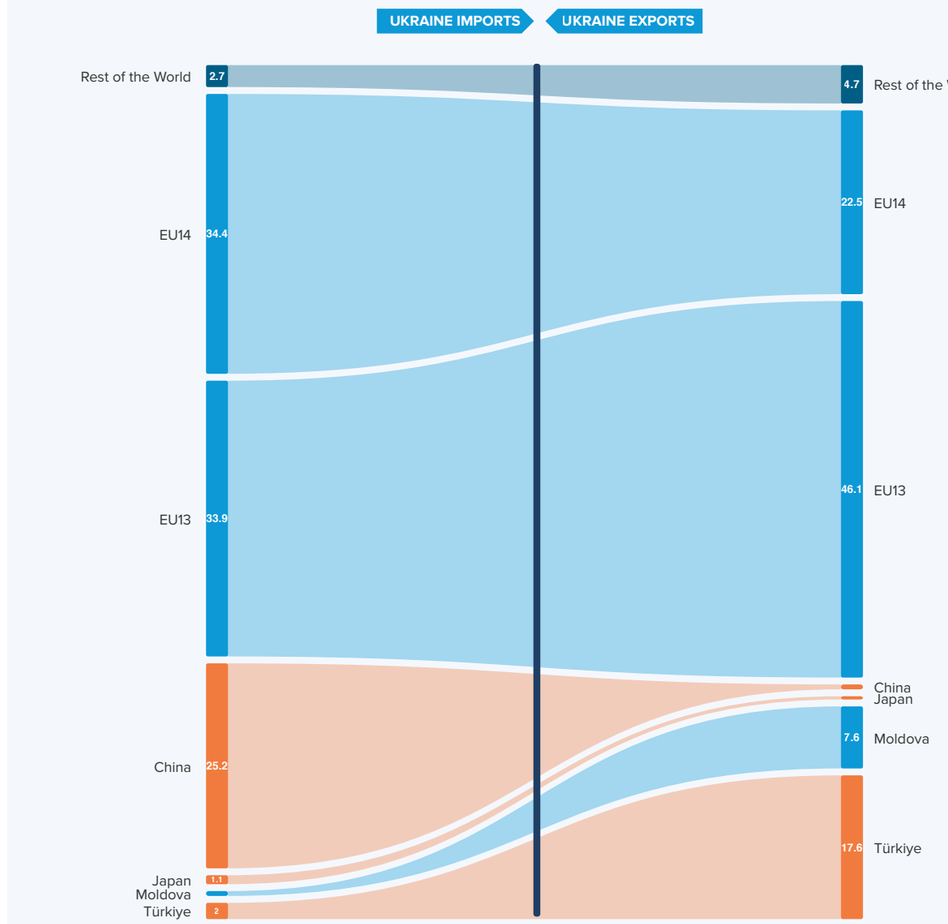


Source: *https://www.paballand.com/ceps/unido-2/sankey/textiles.html*

3.3.8 Wood processing

Wood processing is of a similar size (437 million U.S. dollars) to textiles and a most straightforward, positive case in the entire analysis. Ukraine runs a 5.4 to 1 export surplus in this sector, with exports distributed broadly across virtually every EU Member State – the most pan-European export footprint of any Ukrainian sector. Import structure is healthy: capital equipment and precision woodworking technology from Germany, Poland, Czechia, France and Italy; processed output exported to European markets. EU regulatory compliance (CE marking, sustainability certification, deforestation due diligence) is achievable for established producers. This sector requires no major reconstruction investment or policy transformation, but simply continuity and expansion of what already exists.

FIGURE 16: Ukraine trade flows in wood processing

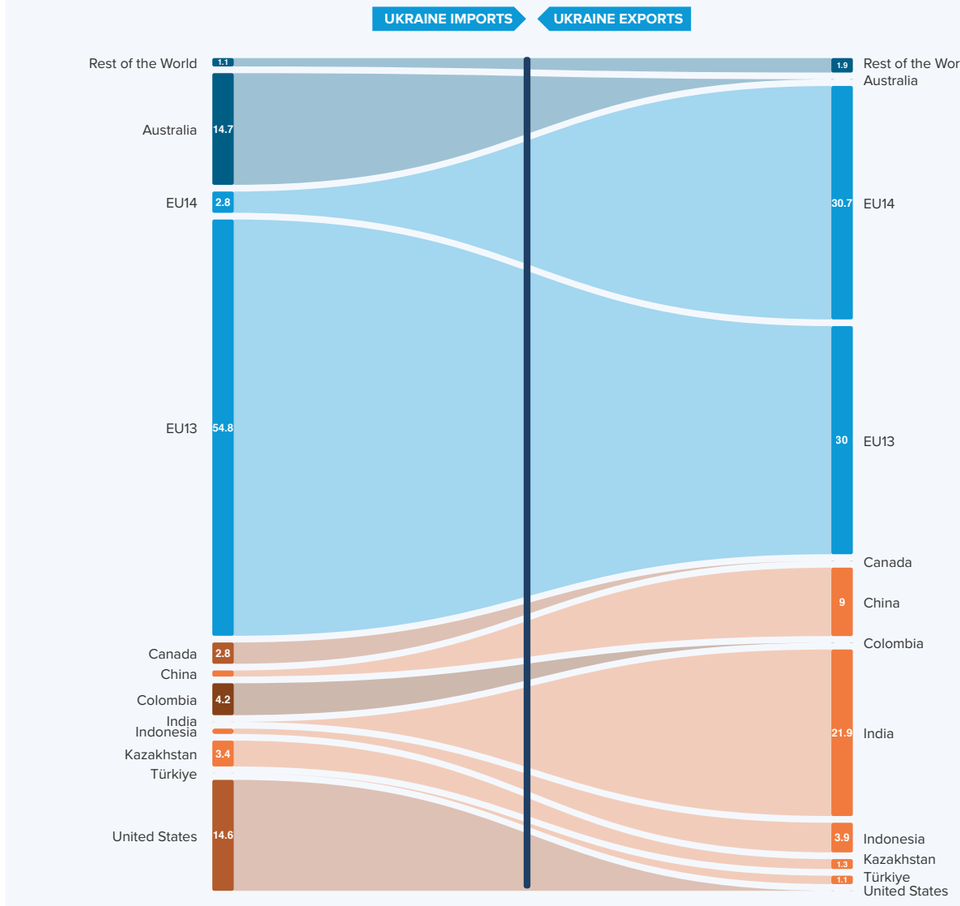


Source: *https://www.paballand.com/ceps/unido-2/sankey/wood_processing.html*

3.3.9 Coal

Coal is a sector in which Ukraine's trade position is structurally mandated to disappear. The current import structure – Poland supplying 54.8% of coal imports at 354 million U.S. dollars is primarily driven by wartime disruptions and reduced access to coking coal reserves in eastern Ukraine, rather than by an underlying structural shift in trade patterns. The EU's coal phase-out policies, carbon pricing framework, and just transition commitments indicate that long-term reconstruction and economic recovery in eastern Ukraine will need to support diversification beyond coal-centred industrial structures in the context of EU accession. Ukrainian policymakers will need to address this explicitly to coal-dependent communities in ways that have not yet happened publicly.

FIGURE 17: Ukraine trade flows in coal

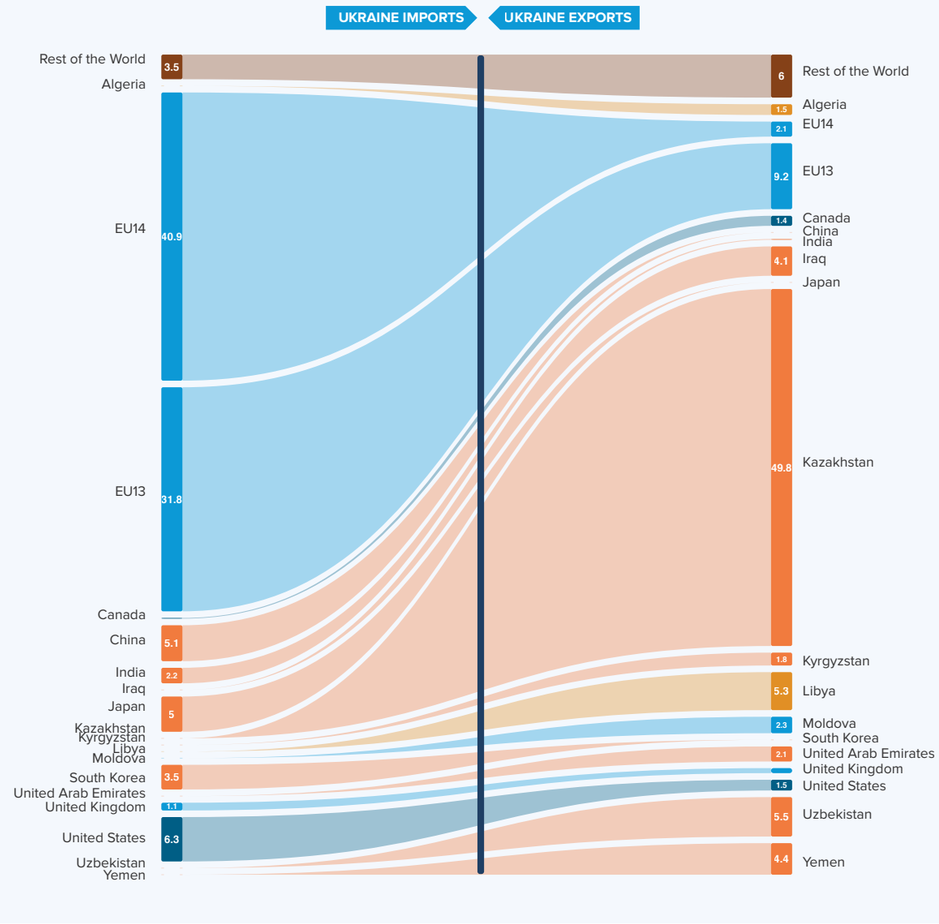


Source: *https://www.paballand.com/ceps/unido-2/sankey/coal.html*

3.3.10 Biotech, greentech and semiconductors

The biotech, greentech and semiconductor sectors share a common structural feature: extreme import deficits against negligible or non-existent competitive exports, with the accession implications in each case imposing major additional adjustment burdens. Biotech shows an import-to-export ratio of 118 to 1 with the EU, with Ukrainian exports concentrated in markets with more permissive regulatory environments (e.g. Kazakhstan, Libya, Iraq, Yemen) that would not survive European regulatory compliance requirements. Greentech's import-to-export ratio of 212 to 1 is the most extreme in the dataset; Ukraine currently has no domestic manufacturing capacity to supply its own green transition and imports every solar panel and wind turbine component.

FIGURE 18: Ukraine trade flows in biotech

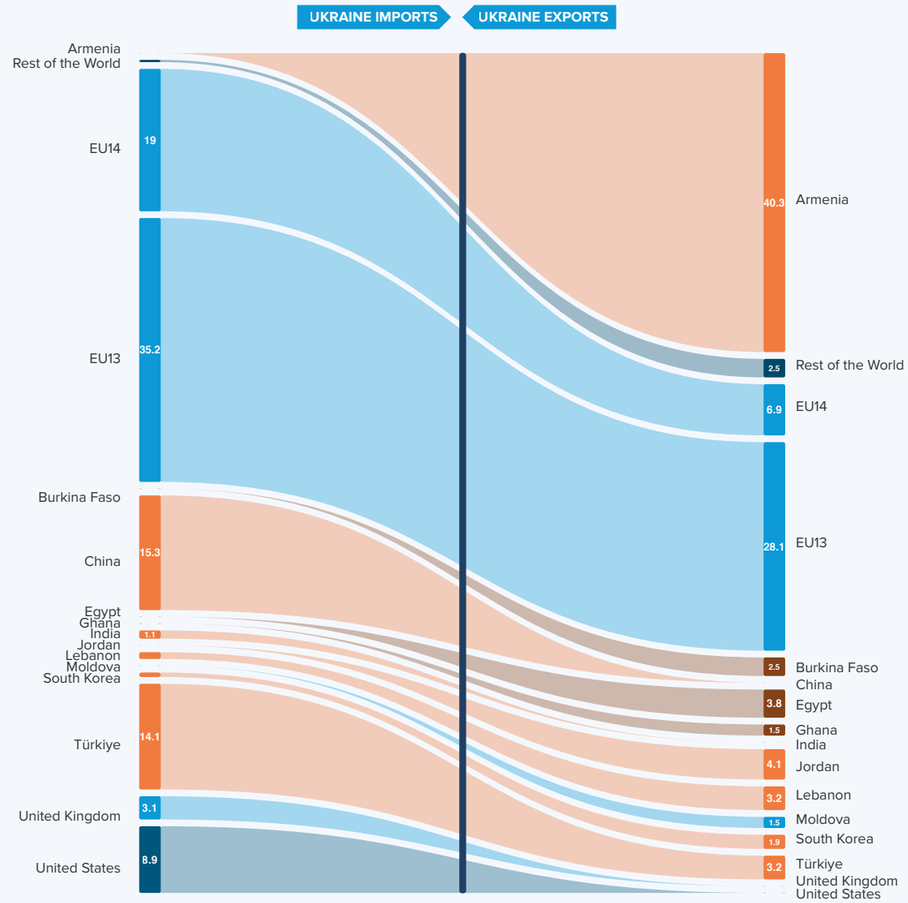


Source: *https://www.paballand.com/ceps/unido-2/sankey/biotech.html*

Semiconductors show near-zero export presence in mainstream markets; Ukraine's semiconductor imports flow through Hungary and Poland not because of EU industrial integration but because global manufacturers use those countries as European distribution and assembly nodes.

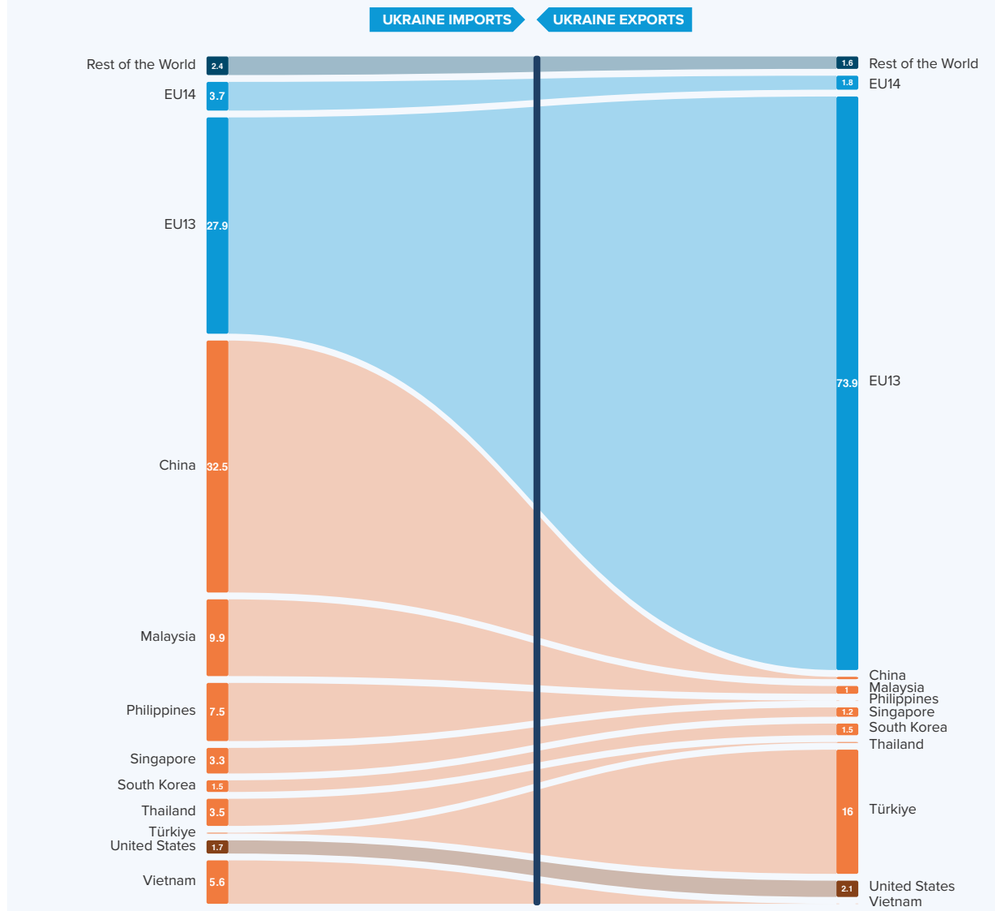
In each of these sectors, reconstruction presents a genuine choice: rebuild infrastructure using imported equipment as before or use reconstruction investment to deliberately build Ukrainian manufacturing capacity in sectors where EU membership obligations and strategic demand are growing. The second path is harder and slower and will require extreme strategic focus as resources are limited, but it could convert accession obligations into industrial opportunity rather than import dependency.

FIGURE 19: Ukraine trade flows in greentech

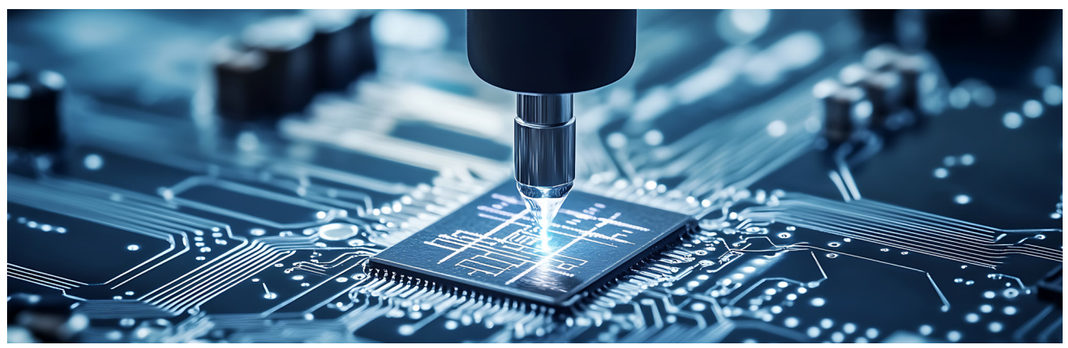


Source: *https://www.paballand.com/ceps/unido-2/sankey/greentech.html*

FIGURE 20: Ukraine trade flows in semiconductors



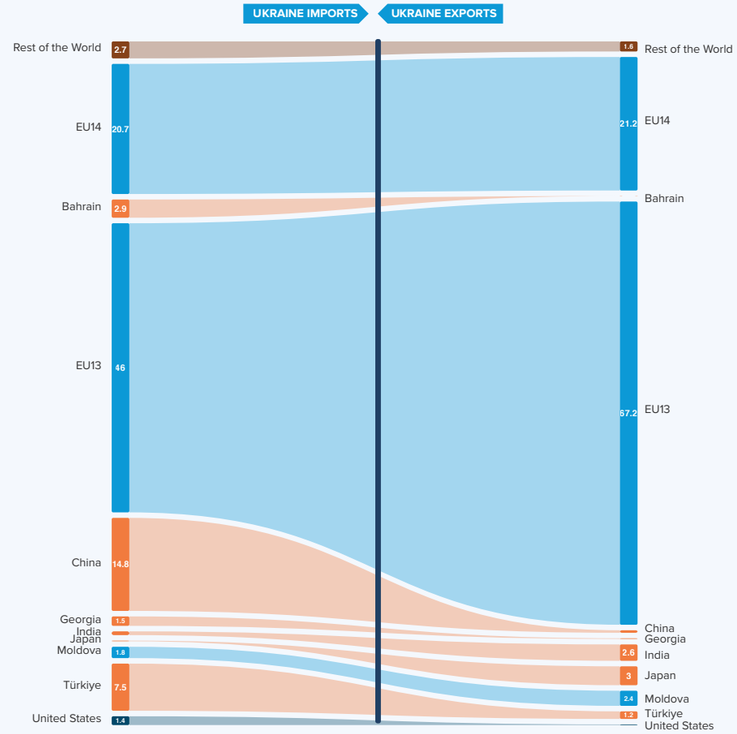
Source: *https://www.paballand.com/ceps/unido-2/sankey/semiconductors.html*



3.3.11 Metallurgy

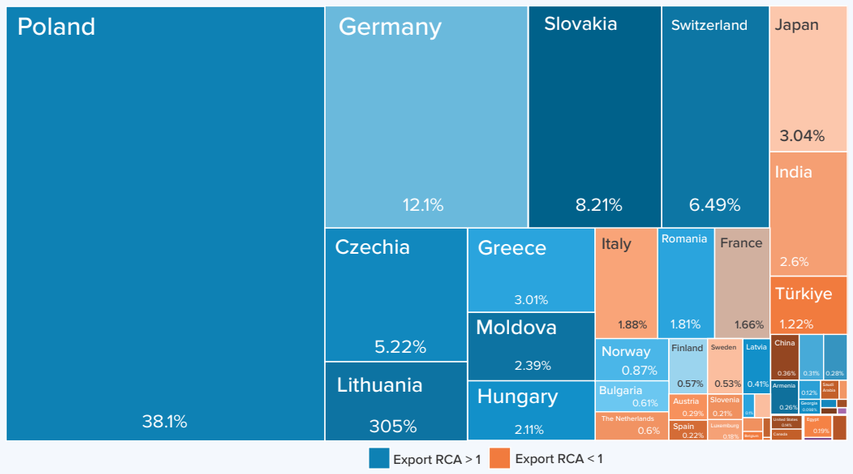
Metallurgy is one of the few sectors where Ukraine runs a structural export surplus (a 2.7 to 1 ratio) and where the export geography tells a story of deep Central European industrial integration. Poland alone absorbs 38.1% of metallurgy exports (159 million U.S. dollars), with Germany at 12.1% and Slovakia at 8.2%. This is more than just corridor trade; it reflects embedded supply relationships with some of Europe's most demanding manufacturing customers. The import side is healthier than most sectors. Poland, Germany, and China lead, but no single source dominates, which suggests a reasonably diversified input base. EU accession would formalise and entrench these relationships, though compliance with EU industrial emissions standards and carbon pricing under the CBAM will require investment in production modernisation.

FIGURE 21: Exports and imports of Ukraine in metallurgy



Source: *https://www.paballand.com/ceps/unido-2/sankey/metallurgy.html*

FIGURE 22: Ukraine export destinations in metallurgy

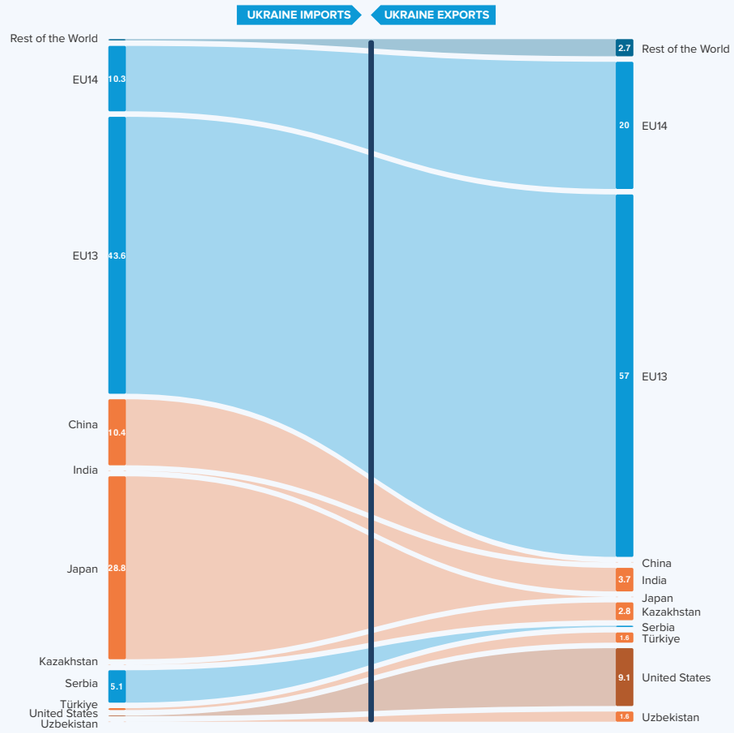


Source: *https://www.paballand.com/ceps/unido-2/trade/metallurgy.html*

3.3.12 Railway

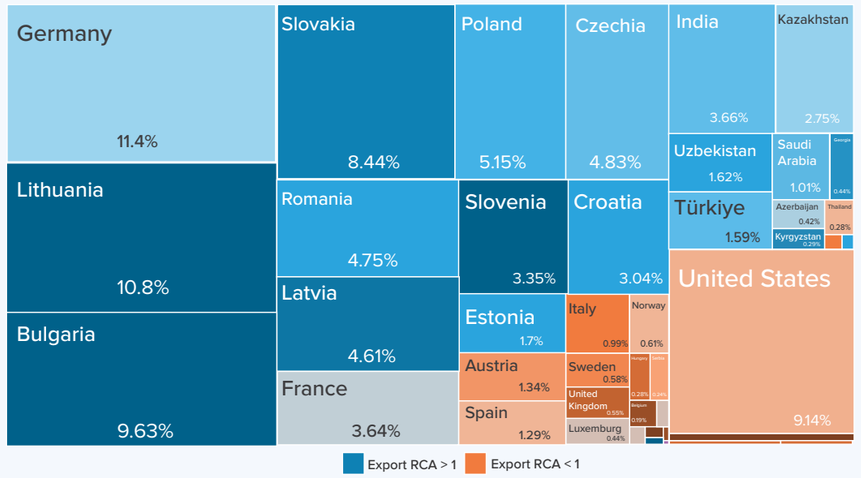
Railway is one of the most counterintuitive findings here. Ukraine runs a small export surplus – 229 million U.S. dollars out versus 129 million U.S. dollars in – in a sector dominated by highly sophisticated European and Japanese manufacturers. The export geography is remarkably broad: Germany (11.4%), Lithuania (10.8%), Bulgaria (9.6%), the US (9.1%), and Slovakia (8.4%) are among the top destinations, suggesting Ukraine supplies specialised components, rolling stock parts, and legacy-compatible equipment across a wide customer base. The import side reveals that Japan supplies 28.8% of imports (37 million U.S. dollars). The accession opportunity is real: European rail interoperability requirements and the EU's push for rail freight expansion as part of its green transition create structural demand for rolling stock and infrastructure components Ukraine already produces.

FIGURE 23: Exports and imports of Ukraine in railway



Source: *https://www.paballand.com/ceps/unido-2/sankey/railway.html*

FIGURE 24: Ukraine export destinations in railway



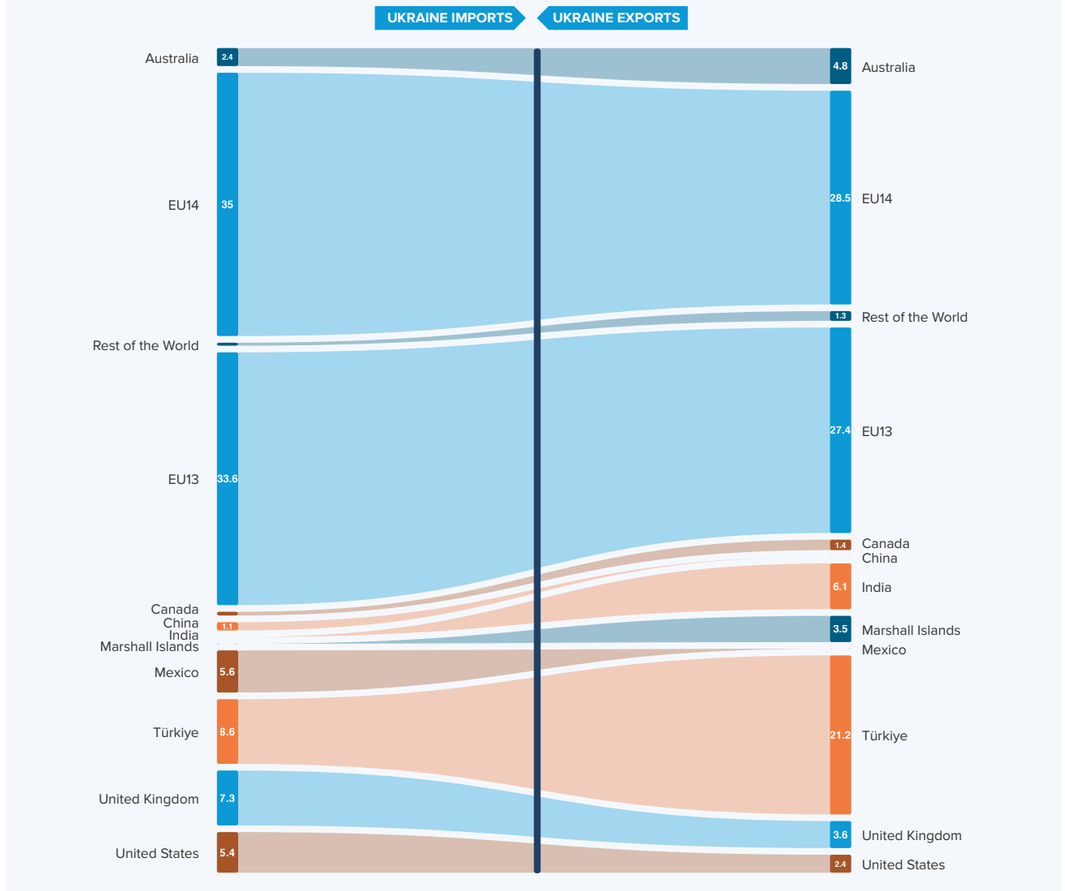
Source: *https://www.paballand.com/ceps/unido-2/trade/railway.html*

3.3.13 Shipbuilding

Shipbuilding is a small but export-positive sector (77 million U.S. dollars out versus 41 million U.S. dollars in) where Türkiye absorbs 21.2% of exports, Romania 11.3%, and the remainder spread across India, Italy, Germany, France, Norway, and others. Pre-war, Ukraine's Black Sea shipyards were genuinely competitive for commercial and naval vessel construction and repair.

The current export pattern reflects residual capacity and components trade rather than active newbuild activity. Post-war reconstruction of Black Sea port and shipyard infrastructure, combined with EU accession and potential NATO naval requirements, could make this sector more strategically significant than its current size suggests.

FIGURE 25: Ukraine trade flows in shipbuilding

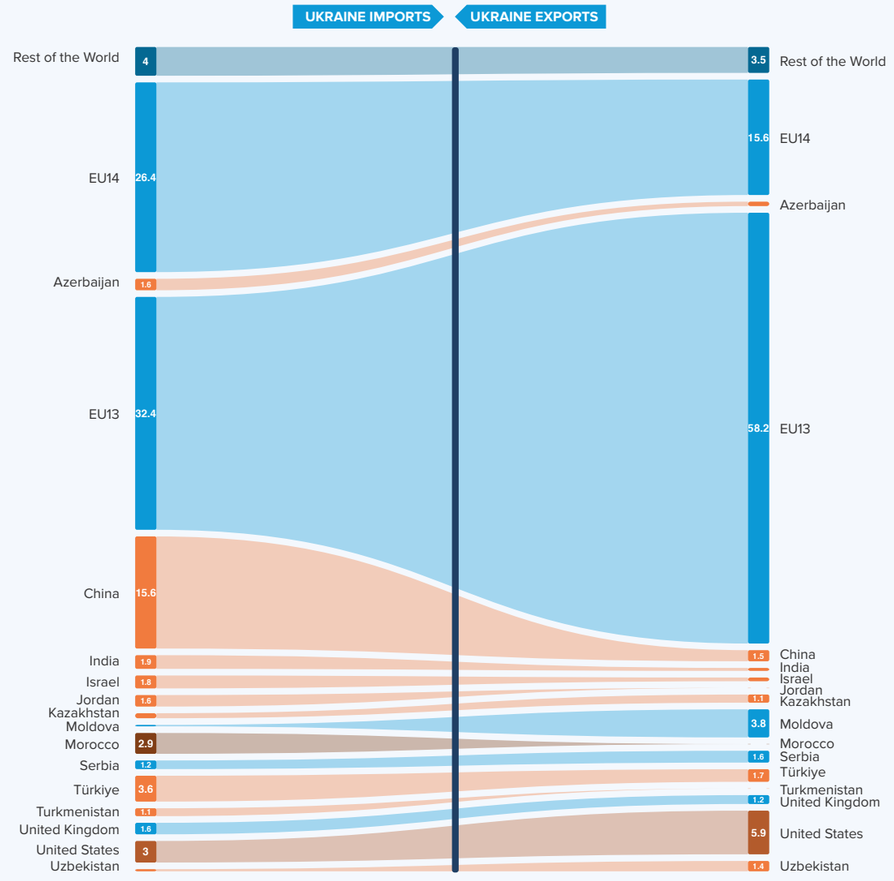


Source: *https://www.paballand.com/ceps/unido-2/sankey/shipbuilding.html*

3.3.14 Chemical engineering

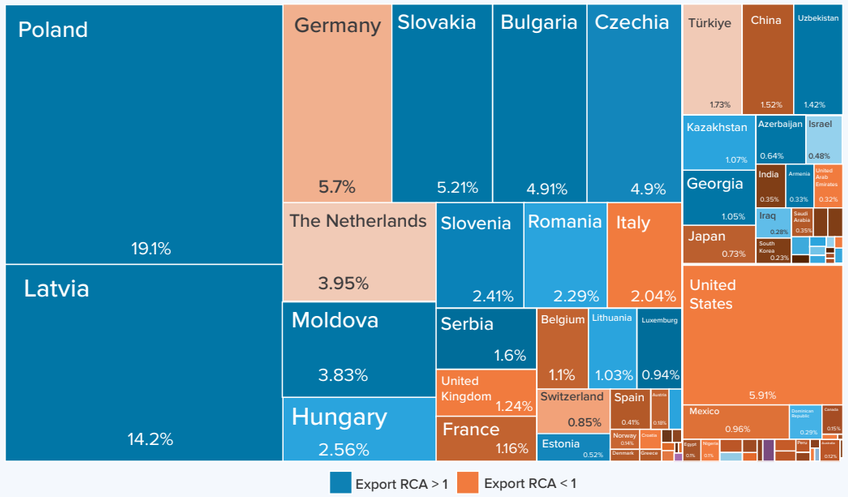
Chemical engineering is a substantial strategic industry (4 billion U.S. dollars in imports against 492 million U.S. dollars in exports – an 8.3 to 1 deficit) that closely mirrors the biotech and greentech structural pattern described earlier. Poland (17.4%) and China (15.6%) lead imports, with Germany, France, and Bulgaria following. The export side, however, shows more competitive focus than the deficit ratio implies: Poland takes 19.1% of exports and Latvia 14.2%, pointing to established supply relationships in specific chemical product categories – industrial chemicals, agrochemicals, and process inputs – rather than dispersed commodity flows. The China import share (15.6%) mirrors the dependency pattern seen across multiple sectors and creates similar resilience questions. EU accession could unlock access to European supply chains that currently operate behind regulatory barriers.

FIGURE 26: Ukraine trade flows in chemical engineering



Source: *https://www.paballand.com/ceps/unido-2/sankey/chemical_engineering.html*

FIGURE 27: Ukraine export destinations in chemical engineering

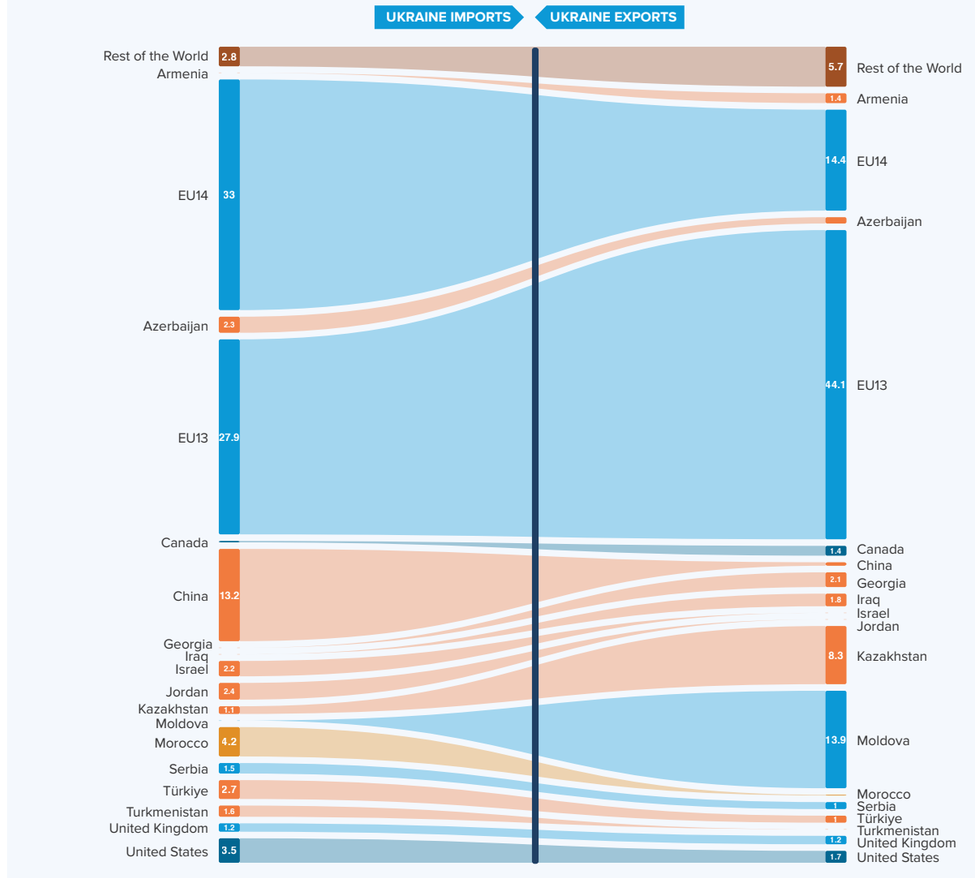


Source: *https://www.paballand.com/ceps/unido-2/trade/chemical_engineering.html*

3.3.15 Agritech

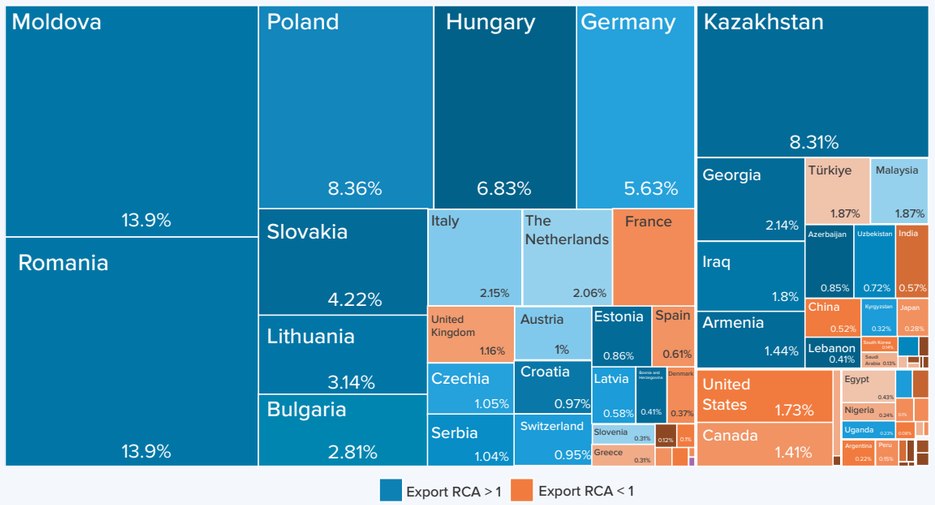
Agritech deserves specific strategic attention. The import-to-export ratio of 35.5 to 1 (2.77 billion U.S. dollars in versus 78 million U.S. dollars out) is extraordinary for a country that is one of the world's largest agricultural exporters. Moldova and Romania lead exports at roughly 14% each, suggesting that what little Agritech Ukraine does export flows to less technologically demanding neighbouring markets. This is one of the clearest examples in the entire trade flow of a sector where Ukraine generates enormous downstream export value while capturing almost none of the upstream technology value chain. EU accession, combined with reconstruction investment, presents a specific and tractable opportunity: agricultural machinery and precision farming technology manufacturing, leveraging Ukraine's existing engineering base (and AI) and its unmatched scale as an end-user and test market.

FIGURE 28: Ukraine trade flows in agritech

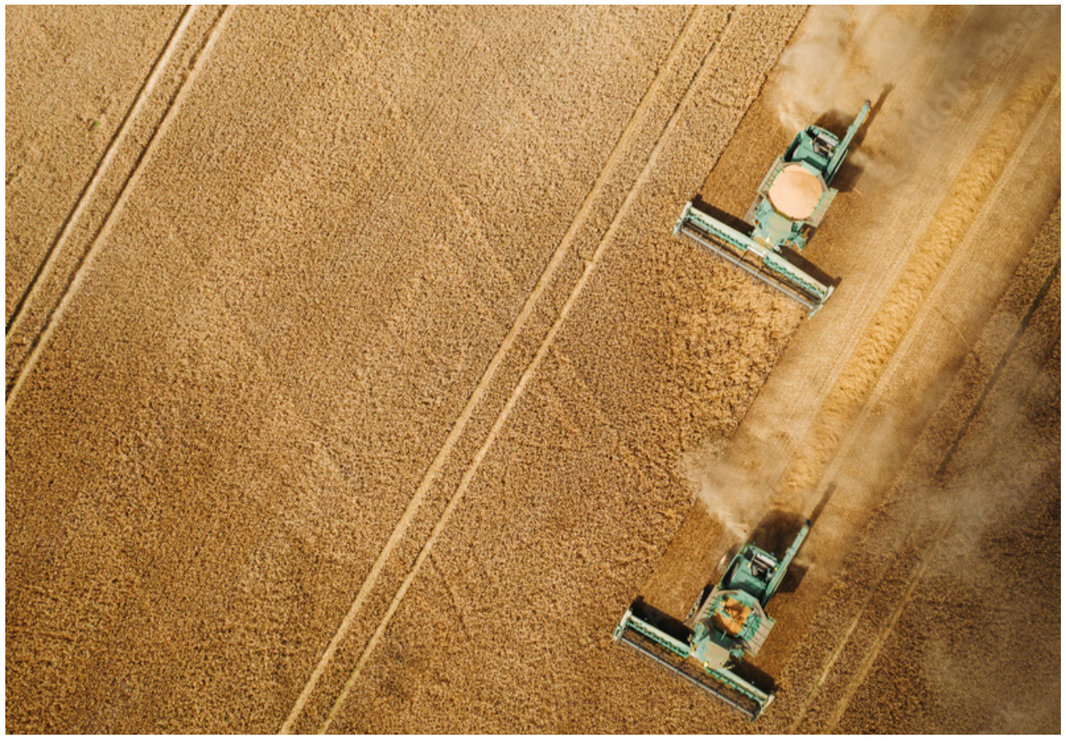


Source: *https://www.paballand.com/ceps/unido-2/sankey/agritech.html*

FIGURE 29: Ukraine export destinations in agritech



Source: *https://www.paballand.com/ceps/unido-2/trade/agritech.html*



3.3.16 Medtech, robotics, and edtech

Medtech, robotics and edtech share the structural profile of extreme import dependency with limited competitive export presence, though each has a distinct character. Medtech shows a 20 to 1 import deficit (992 million U.S. dollars in, 49 million U.S. dollars out), with a fragmented export base, notably Pakistan at 9.9% and India at 5.3%. This suggests exports flow to markets with lower regulatory thresholds rather than competitive EU supply relationships. Robotics is smaller but has a more promising export structure: Poland, Romania, and Slovakia together absorb nearly 40% of the 44.5 million U.S. dollars in exports, indicating nascent integration into Central European automation supply chains. The 22% China share of robotics imports mirrors the UAS dependency pattern and carries the same strategic vulnerability. Edtech is the most unusual: a 3.9 to 1 import deficit (103 million U.S. dollars in, 26 million out), with China and Vietnam dominating imports and the export geography concentrated in France, Belgium and Hungary. Ukraine's strong IT talent base makes edtech the sector in this group with the most realistic path to export competitiveness, but it requires substantial investment in product development and EU market certification.

4

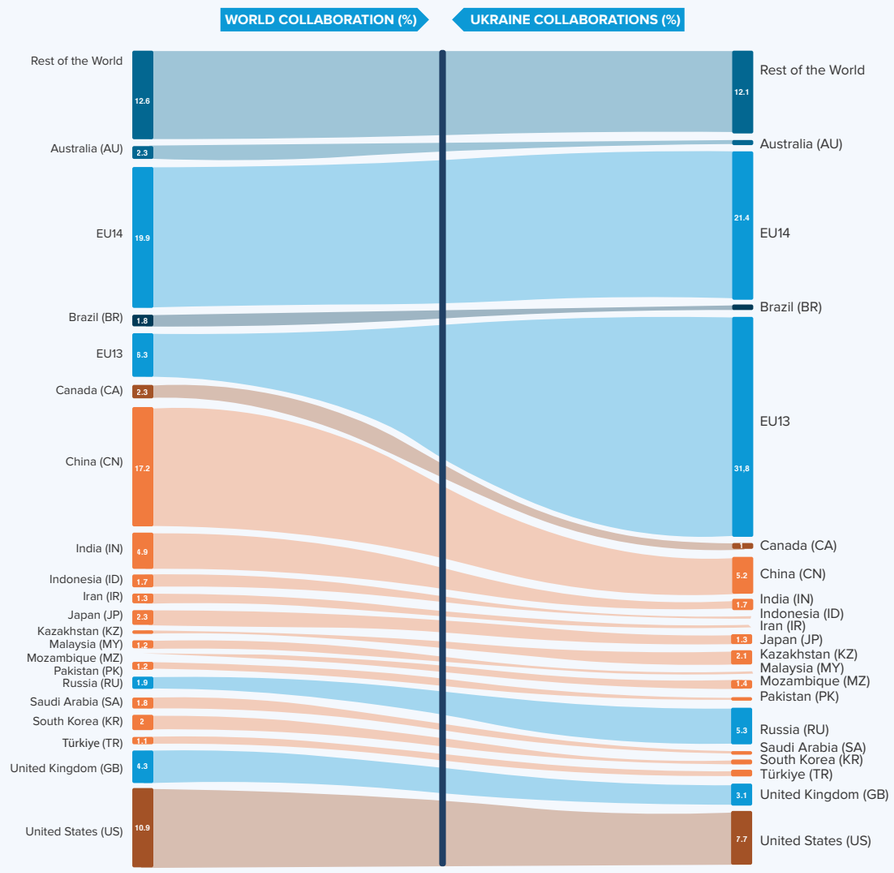
Scientific Collaboration Networks

Ukraine’s scientific collaboration network, examined across all 25 strategic industries combined, reveals a country whose research system is already deeply embedded in European science. But it is also one that is systematically disconnected from the most dynamic and fastest-growing research communities in the world.

4.1 THE OVERALL ARCHITECTURE OF UKRAINE'S RESEARCH NETWORK

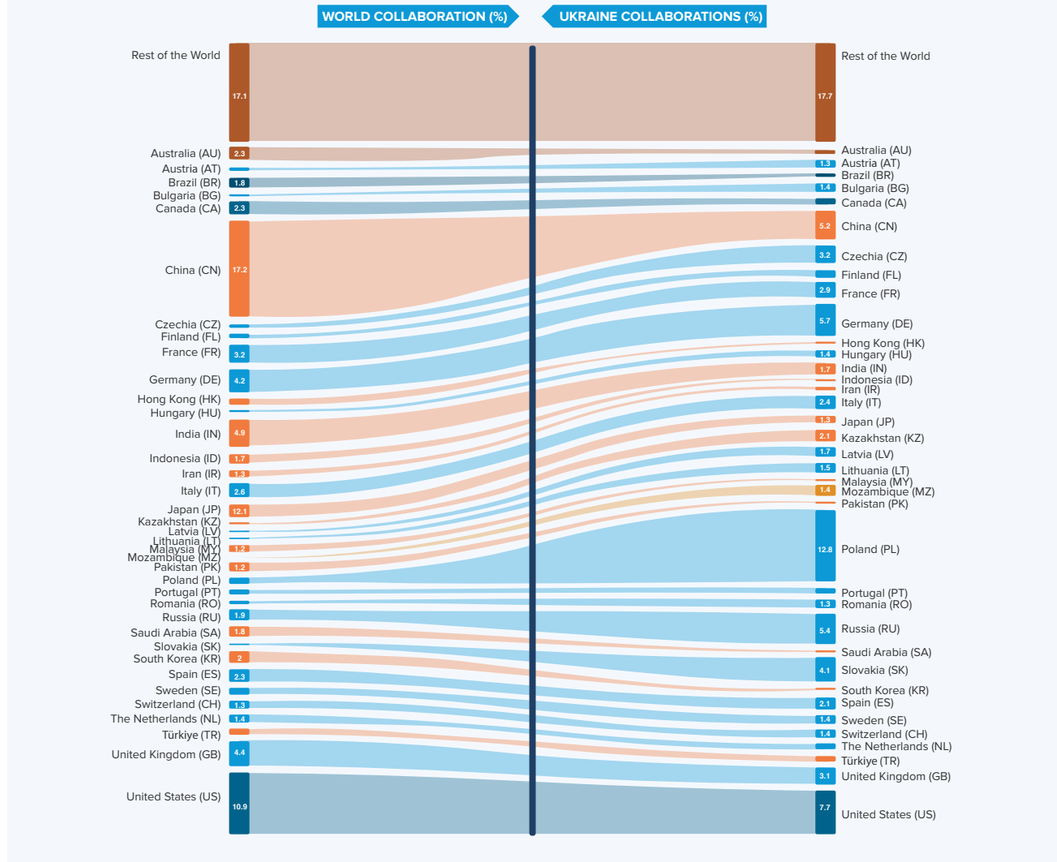
Ukraine's scientific collaboration network, examined across all 25 strategic industries combined, reveals a country whose research system is already deeply embedded in European science. But it is also one that is systematically disconnected from the most dynamic and fastest-growing research communities in the world.

FIGURE 30: Ukraine's research collaboration network (EU-grouped)



The EU collectively accounts for roughly 53% of Ukraine's research collaboration links, and the structure of that European integration contains an analytically important finding that goes beyond what geography alone would predict. EU13 over-representation is expected and confirmed: Central and Eastern European economies account for 31.8% of Ukraine's collaboration links against a global research share of just 6.3%. This is a five-fold over-representation driven by shared institutional legacies, co-located research infrastructure, and the gravitational pull of scientific communities that share both a post-Soviet transition history and a direct geopolitical stake in Ukraine's reconstruction. What is more analytically striking is the EU14 result: these fourteen advanced Western European economies account for 21.4% of Ukraine's collaboration links against a global research share of 19.9%. This is a meaningful and far less obvious over-representation that reflects already strong scientific integration with Western Europe. It extends well beyond proximity and points to decades of deliberate partnership-building through European framework programmes, bilateral research agreements, and the steady westward reorientation of Ukraine's scientific community that predates the full-scale invasion. Ukraine is not merely a scientific neighbour of Central Europe. By the metrics of research collaboration intensity, it is already a participant in the Western European scientific space to a degree that the trade data significantly understate.

FIGURE 31: Ukraine's research collaboration network



Within the EU, the bilateral country-level data reveal a hierarchy that carries direct strategic implications. Poland, at 12.8% of all Ukraine's research links against a global share of 1.1% – a ratio of more than eleven to one – is the dominant scientific partner by an extraordinary margin, reflecting not merely geographic proximity but decades of institutional co-investment, shared research infrastructure, and the deliberate deepening of bilateral scientific programmes that accelerated after 2014. Slovakia, at 4.1% against 0.3% globally, and Czechia, at 3.2% against 0.7% globally, together with Latvia and Lithuania, which each contribute around 1.5%-1.7% against global shares of below 0.1%, form a core Central European cluster that accounts for over 23% of Ukraine's total collaboration while representing barely 2.3% of global scientific output. This concentration of institutional proximity is both Ukraine's greatest scientific asset and a source of structural fragility if it comes at the cost of engagement with larger research economies.

Germany, at 5.7% against a global share of 4.2%, is the one large Western European economy appearing modestly above its expected weight, suggesting industrial research integration rather than corridor adjacency. France, at 2.9% against 3.2% globally, the UK at 3.1% against 4.4% globally, and Italy at 2.4% against 2.6% globally, are each a little below their expected weights. Closing this gap with France, the UK, and Italy represents one of the highest-return investments available in Ukraine's scientific diplomacy portfolio.

Three structural gaps in Ukraine's global research connections demand specific attention. First and most consequential is China: at 5.2% of Ukraine's collaboration links against a global research share of 17.2%, the under-collaboration is the largest absolute gap in the entire dataset, holding across virtually every sector and representing a systematic disconnection from the world's most prolific research producer in many key strategic technologies that are central to Ukraine's reconstruction agenda. Second is the US, where 7.7% of Ukraine's links against a global share of 10.9% represents a moderate proportional gap but a large absolute opportunity cost: American research institutions lead globally in the commercially consequential frontier sectors where Ukraine most urgently needs to convert research relationships into joint commercial invention. Third is the cluster of East Asian innovation leaders – South Korea at 0.6% against 2.0% globally, and Japan at 1.3% against 2.3% globally – whose near-absence from Ukraine's research network is particularly costly in specific sectors. In contrast, Kazakhstan at 2.1% against 0.2% globally and Mozambique at 1.4% against a near-zero global share represent the persistence of Soviet-era bilateral relationships which, while reflecting genuine historical depth, consume institutional bandwidth that could be redirected towards the research partnerships that Ukraine's reconstruction and accession trajectory actually requires.

4.2 SECTORS WHERE THE NETWORK IS STRATEGICALLY WELL-POSITIONED

Nuclear stands out as Ukraine's most broadly anchored research network in the entire dataset. Germany at 7.1%, Poland at 7.3%, France at 5.2%, Italy at 5.3%, the UK at 4.2%, and the US at 6.2% all appear at or above their expected global weights – a rare configuration that reflects Ukraine's decades of scientific engagement with Western nuclear operators and reactor designers. This network is a direct asset for the energy reconstruction agenda. Wood processing is similarly well-structured: Poland, Slovakia, and Czechia account for over 35% of links, mirroring the supply chain relationships that already drive Ukraine's strongest trade surplus, with Sweden's above-expected presence adding valuable access to sustainable forestry and engineered wood innovation. Metallurgy reveals an unusually balanced four-way structure – Poland, Germany, Russian Federation and China each at between roughly 9% and 13% – where the EU commercial relationships are real and deep, even if the Russian legacy share warrants monitoring.

Chemical engineering is perhaps the most commercially actionable network in the dataset, with Poland, Germany, Slovakia, and France together accounting for over 37% of links, all above their expected weights, and all directly relevant to the agrochemical and process chemical export relationships the trade analysis identifies as commercially significant.

4.3 SECTORS WHERE THE NETWORK IS CONCENTRATED BUT COMMERCIALLY COHERENT

Several sectors show extreme Central European concentration that, while narrow, is structurally aligned with where Ukraine's actual trade relationships and industrial supply chains are located. Automotive is the clearest case: Poland at 21% against a global share of 1.4% – a ratio of 15 to 1 – directly reflects the Central European manufacturing corridor embedding that the trade data confirms. Slovakia at 8.6% and Germany at 4.3% reinforce this picture. Railway produces the most extreme single bilateral over-representation in the entire dataset: Slovakia at 17.6% against a global share of just 0.6% – nearly 30 to 1 – reflecting shared Soviet-era infrastructure standards and a direct commercial relationship with one of Ukraine's largest railway export customers. Agritech shows Poland at 15.4%, Latvia at 6.9%, and Slovakia at 5.5%, which together account for nearly 28% of all links. This is commercially coherent given Central European agricultural supply chain integration – though the contrast with the 35 to 1 agritech trade deficit remains the starkest research-to-commerce gap in the entire analysis. Textiles mirrors this pattern with Poland, Slovakia, and Czechia together above 30%, though the near-total absence of Italy at just 0.4% is the most actionable gap, given Italy's status as textile customer and global leader in technical textiles research. Wood processing, biotech, and shipbuilding follow similar patterns of Central European concentration with specific actionable gaps: in biotech, the absence of South Korea, Japan, and China from a network otherwise strong with Germany and France; and in shipbuilding, the complete absence of South Korea, Japan, Norway, and the Netherlands, despite these being the countries that define global shipbuilding technology.

4.4 SECTORS WHERE THE NETWORK HAS URGENT STRATEGIC DEFICIENCIES

The most concerning finding across the entire dataset is the degree to which several of Ukraine's most strategically critical sectors show research collaboration patterns that are either misaligned with or actively contrary to Ukraine's security and industrial interests. UAS is the most alarming case in the dataset. Russia at 12.3% is the second-largest bilateral partner after Poland at 16.4% – a Soviet aerospace legacy that continues to appear in the co-publication record because of a lag. At 10.3%, China, while below its global share of 25.1%, remains meaningfully present in a sector where Chinese import dependency already reaches 71.1% – a dual vulnerability in Ukraine's most operationally critical technology domain. Germany and the US, the partners that matter most, are both below their expected weights. Secure cyberspace raises similar concerns: Kazakhstan at 7.3% against a global share of 0.2% is the most extreme bilateral over-representation in any sector, and Russia at 3.5% remains a persistent presence, while the US at 7.4% is below its expected weight of 11.4% – a significant gap given American leadership in offensive and defensive cyber research. Robotics combines Polish and Slovakian dominance, with Russia at 8.3% – one of the highest legacy shares in any sector – and the near-total absence of Japan and South Korea at 0.6% and 0.2% respectively against global shares of 3.7% and 2.1%: Ukraine has one of the richest robotics publication networks in the dataset but is essentially disconnected from the research communities actually defining the global frontier.

Semiconductors contains the most encouraging bilateral finding in this group. At 10.1%, Germany is nearly double its expected weight but is undermined by the near-total absence of the three most commercially sophisticated semiconductor ecosystems in the world outside the US: South Korea at 0.3%; Taiwan at 0.3%; and Singapore at 0.1%. AI shows the US at 5.9% against a 12.8% global share, a strong under-representation in a sector where American institutions define the commercial frontier. Defencetech has the US approaching its expected weight at 9.8% but Russia is still at 6.5%, and the overall network is the smallest of any sector – a structural thinness that is directly inconsistent with Ukraine's ambition to build a Western-oriented defence industrial base. Edtech deserves a separate note for the most extraordinary anomaly in the entire dataset: Mozambique accounting for 30.2% of all edtech collaboration links - the highest bilateral share of any country in any sector. This is driven by Soviet-era linkages persisting long after any strategic rationale has expired, absorbing bandwidth that should be redirected toward the US (at 12.7%) and Israel, both of which show genuine and commercially promising engagement with Ukraine's digital education ecosystem.

5

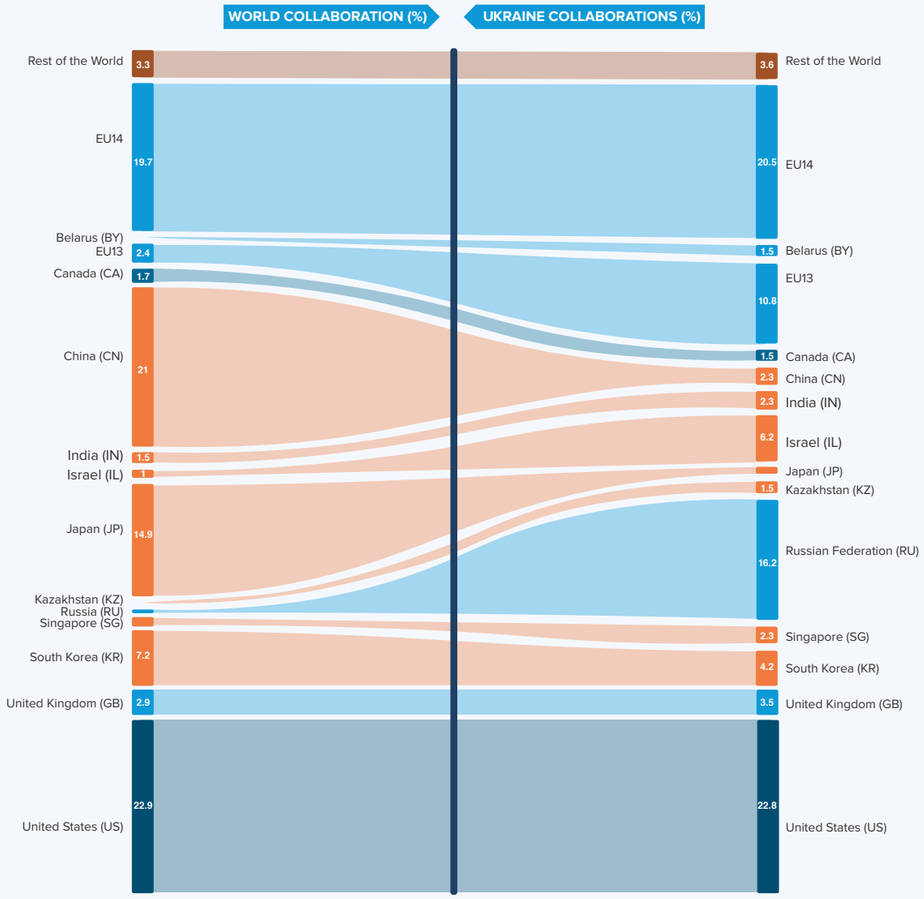
Ukraine’s Patent Co-Invention Network

In this section, Ukraine’s patent co-invention network is examined across all strategic industries combined.

5.1 THE OVERALL ARCHITECTURE OF UKRAINE'S PATENT CO-INVENTION NETWORK

Ukraine's patent co-invention network, examined across all strategic industries combined, tells a different story from the research collaboration data. See Figure 24 below for details.

FIGURE 32: Ukraine's technology collaboration network in key industries (EU-grouped)



Source: *https://www.paballand.com/ceps/unido-2/sankey/regpat/all-eu_countries.html*

Where the research network is broad, European-anchored, and institutionally deep, the co-patent portfolio is extraordinarily thin, and its structure is dominated by a single relationship that is no longer operationally available. Russia, at 16.2% of all Ukraine's co-patent links against a global share of just 0.4%, is the most extreme bilateral over-representation in the entire patent dataset, and a direct legacy of the Soviet defence-industrial and engineering co-development programmes that constituted the primary channel through which Ukrainian research was historically converted into commercial invention. This legacy is now severed, and what remains in its place is a co-patent portfolio that is both small in absolute terms and structurally misaligned with where Ukraine needs to build commercial technology relationships.

The EU collectively performs better than the research data might predict: EU14 accounts for 20.5% of co-patent links against a global research share of 19.7% – at roughly the expected weight – and the EU13 at 10.8% against 2.4% globally continues the pattern of Central European over-representation seen in research collaboration.

The US, strikingly, is one encouraging finding in the aggregate patent data: at 22.8% of Ukraine's co-patent links against a global share of 22.9%, the US appears almost exactly at its expected weight. This is in sharp contrast to the under-collaboration seen in research, and one that reflects diaspora-driven linkages, but representing a commercial technology relationship with scale.

At just 0.8% against a global patent share of 14.9%, Japan's near-total absence from Ukraine's co-invention network points to a structural disconnection from Asian commercial technology ecosystems that is even more pronounced in patents than in research. South Korea at 4.2% against 7.2% globally, and China at 2.3% against 21.0%, complete a picture of systematic under-connection with East Asian innovation leaders that holds across virtually every sector. Israel at 6.2% against a global share of just 1.0% is a striking positive outlier in the dataset – a six-fold over-representation that reflects the emergence of Ukraine-Israel commercial technology co-development. Within the EU, Germany at 6.6% against a global share of 7.8% is modestly below expected weight but present, while France at 4.2% above its 3.4% global share is one of the few EU14 countries performing above expectation. The overall picture is of a commercial technology network that has lost its Soviet-era foundation but has not yet built the Western institutional partnerships needed to replace it, and whose most promising emerging relationships – with the US through diaspora channels and with Israel through entrepreneurial networks – are fragile and individualistic rather than institutionally anchored.

5.2 INDUSTRY-LEVEL HETEROGENEITY

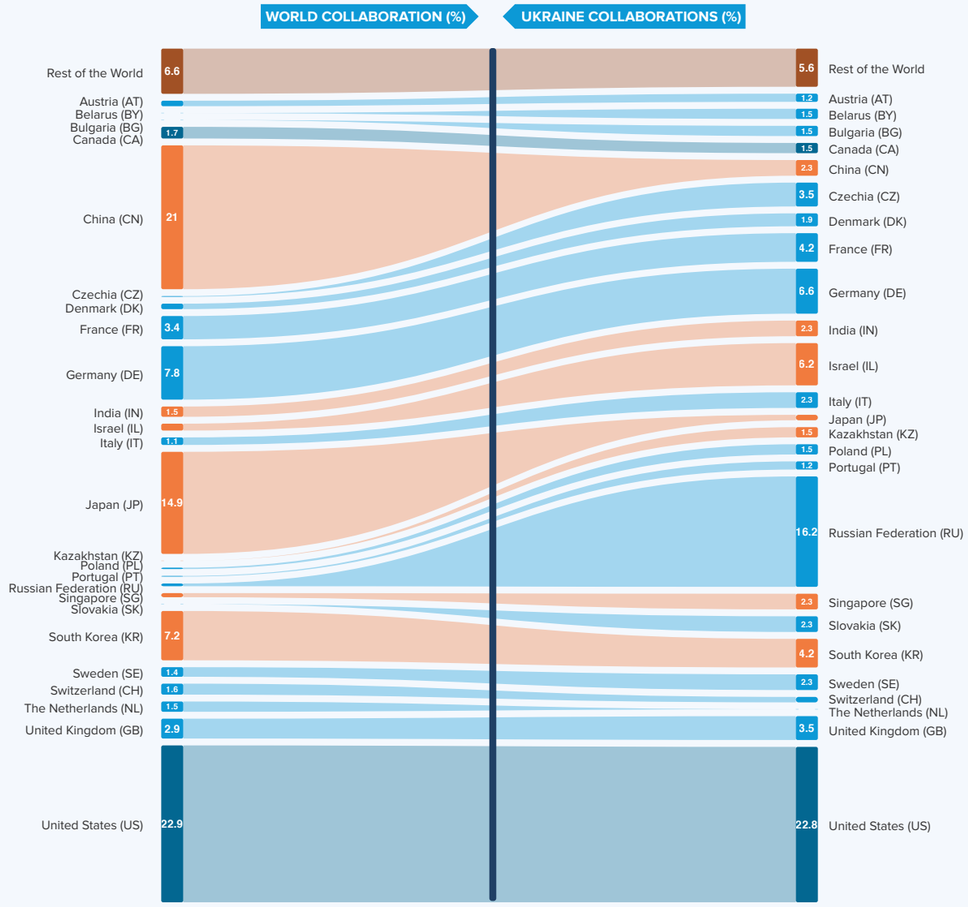
Ukraine's commercial technology partnerships are extraordinarily thin across virtually every strategic industry. In the first place, PCT patents are rare. But still, the gap between research collaboration depth and joint commercial invention is the most structurally important weakness in Ukraine's research and innovation system. The average strategic industry has fewer than 15 co-patents in total for 2020-2024. Several sectors with rich and active research networks – robotics with 1,308 research links but 2 co-patents, govtech with meaningful European scientific engagement but zero commercial IP, railway with a trade surplus but essentially no joint invention – illustrate that, more than research capacity, a key issue is the institutional infrastructure that converts scientific relationships into commercial technology partnerships. This gap is systemic, and it reflects the absence of capital of course, but also of technology transfer offices, joint venture frameworks, IP protection regimes, and industrial partnership programmes through which research economies convert scientific capital into commercial invention.

The second headline finding is the depth and persistence of the Russian Federation's dominance across the legacy co-patent portfolio. Again, this is a lag and it precedes the full-scale invasion, but the Russian Federation used to hold a strong footprint in nuclear co-patents, UAS patents, biotech, chemical engineering, automotive and greentech – in orders of magnitude above its global patent share. These are the structural remains of Soviet joint commercial invention programmes that constituted Ukraine's large share of commercial technology infrastructure in sector after sector. That infrastructure is now severed and geopolitically unavailable, leaving a vacuum that has not been filled. The most urgent institutional challenge is not building from zero, it is replacing a destroyed foundation with a Western-anchored alternative before the window of reconstruction investment closes.

Against this picture of systematic thinness and legacy dominance, three sectors stand out as bright spots that illustrate what is possible. AI, with the US, South Korea, Israel, Germany, and the UK all present at above-expected weights, is the sector where Ukraine's commercial technology network most closely resembles what a modern innovation economy looks like, driven by diaspora inventors and entrepreneurial connections rather than institutional programmes. Secure cyberspace, where the US is dominant and Israel meaningfully present, is the second most commercially active network and the one most directly connected to Ukraine's internationally recognised operational expertise. With South Korea as the dominant partner, extended reality points to a commercially driven bilateral technology relationship with Korean consumer electronics firms that has emerged organically and points to a model worth deliberately replicating. These three key strategic industries share a common structural feature.

The most acute sectoral gaps are nuclear, UAS, defencetech, semiconductors, and robotics. In each of these sectors, Ukraine has meaningful scientific relationships with Western partners, but essentially, those relationships have generated no joint commercial IP. The US and Germany are particularly absent in several key sectors.

FIGURE 33: Ukraine's technology collaboration network in key industries



Source: *https://www.paballand.com/ceps/unido-2/sankey/regpat/all-eu_countries.html*

Synthesis

The three-layer analysis of trade, science, and patents converges on a consistent and coherent picture of Ukraine's strategic industrial position. **Ukraine is deeply integrated into European trade, research and innovation systems, with a network anchored in Central and Eastern Europe and increasingly extending into Western Europe**. This integration reflects strong supply chain embedding, decades of institutional scientific cooperation, and the geographic and economic logic of Ukraine's position at the intersection of European and Eurasian industrial corridors.

At the same time, across all three data layers, the same structural weaknesses recur. **The commercial technology layer is very thin relative to the scientific layer – research capacity has not been converted into joint innovation with Western industrial partners**. The export base is concentrated in resource and manufacturing sectors with limited technological complexity. And critical import dependencies, particularly on China in strategically sensitive sectors, are clearly visible when the data are examined at the industry level.

The most important strategic choice that this analysis illuminates is not between European integration and an alternative trajectory – that choice has been made, and the data confirms it is already the structural reality of Ukraine's economic position. The central strategic choice concerns the terms on which integration deepens.

Reconstruction investment allocated primarily towards restoring pre-war production structures will entrench Ukraine in a role as a supplier of raw materials, low-complexity manufactures, and low-cost labour for European supply chains. This path is commercially coherent in the short run but represents a missed opportunity to use the reconstruction moment – when institutional arrangements are being established, investment flows are large, and the political economy of transformation is unusually permissive – to move Ukraine's position in European and global value chains towards greater complexity, higher value, and less dependence on sectors that carry either commodity price risks or strategic vulnerabilities. **The goal would be to establish Kyiv as a key hub in the region.**

Reconstruction investment explicitly directed at value-chain upgrading in sectors where Ukraine has competitive foundations – defencetech, automotive, aerospace maintenance and overhaul, chemical engineering, medtech, cybersecurity – can achieve both economic and strategic objectives simultaneously. **The sectors most likely to generate the kind of deep EU industrial integration that accession ultimately requires are those where two-way supply chain relationships already exist**, where European demand is structural rather than transitional, and where Ukrainian capacity, if rebuilt and modernised, meets competitive standards rather than simply filling a labour-cost gap.

EU accession is not just a question of market access. It is a sector-by-sector compliance gate that will determine which industrial bets can actually scale. Trade and network analyses are often read as maps of opportunity, but accession determines how many of those opportunities are executable. In practice, the most decisive bottlenecks will not be tariffs, but conformity assessment, standards and certification, carbon and environmental compliance, and the institutional capacity to meet EU regulatory regimes.

This reframes deepening integration as an operational sequencing problem: some sectors can expand quickly because they already operate near-EU requirements, while others will remain import-dependent or confined to non-EU markets until compliance capacity is built.

The implication is a conclusion that is currently easy to miss: Ukraine's reconstruction strategy should treat EU accession obligations as an industrial policy instrument rather than an external constraint. Where compliance costs are unavoidable – carbon intensity, chemicals and product safety requirements, interoperability standards – reconstruction finance and donor support should be channelled into building the testing, certification, quality management, and regulatory implementation capacity that allows Ukrainian firms to compete inside EU supply chains. Where compliance will structurally erase parts of the pre-war model (coal) or undermine low-cost positioning (certain labour-arbitrage niches), policy should explicitly pivot toward value-chain upgrading rather than attempting to preserve legacy comparative advantages. Section 7 translates this logic into targeted recommendations, prioritising investments that both reduce strategic dependencies and build accession-ready capability in the sectors where Ukraine already shows the strongest foundations.

Policy Recommendations

ENERGY RECONSTRUCTION AS THE ENGINE OF INTELLIGENCE TRANSITION

The 9.3 billion U.S. dollars energy import bill is one of the war's most economically damaging consequences, and its most tractable reconstruction priority. But a big case for making it the centrepiece of recovery is this: AI infrastructure is a power problem before it is anything else. Training clusters, inference at scale, sovereign model deployment – all of it runs on dense, stable, abundant electricity. Ukraine's reconstruction window coincides exactly with that demand curve hitting vertical. Rebuild nuclear fast for the baseload that compute requires, deploy renewables at pace in the West for the green-certified power that hyperscalers and AI investors demand, reconstruct transmission as the connective tissue between the two, and Ukraine doesn't just close a current account gap, it builds the physical substrate for a leapfrog to state-of-the-art AI capability. No legacy grid constraints, no incumbent utility politics, no decade-long planning queues. Just a fast build, at the right moment, on the right foundation.

A DEDICATED DUAL-USE INDUSTRIALISATION PROGRAMME DURING RECONSTRUCTION

Ukraine has accumulated extraordinary operational experience in technologies including drones and autonomous systems, advanced sensors, secure communications, AI-enabled logistics, and additive manufacturing. These have substantial civilian applications in agriculture, logistics, infrastructure monitoring, emergency response, and industrial automation. The reconstruction window is the moment to convert this knowledge into a dual-use industrial base oriented toward European civilian markets, with security-relevant applications as a secondary outlet. A dual-use industrialisation programme should be structured around three axes: (1) scaling domestic UAS and autonomous systems production using European-sourced components, specifically reducing the Chinese import share, with civilian applications (precision agriculture, infrastructure inspection, logistics) as the primary commercial market; (2) developing EU-aligned export licensing, certification, and quality management frameworks that meet civilian regulatory standards while remaining compatible with security-sector procurement; and (3) deepening industrial partnerships with EU Member States where dual-use supply chains are already developing, anchoring Ukrainian capacity in the European civilian technology base.

AUTOMOTIVE RECONSTRUCTION FOR SUPPLY CHAIN RE-EMBEDDING WITH EUROPEAN MANUFACTURERS

The pre-war automotive components industry represents Ukraine's foundation for deep EU industrial integration. Reconstruction investment in the automotive sector should be explicitly linked to securing re-entry into European OEM supply chains to reconstruct capacity in western Ukrainian locations that are logistically accessible and physically secure. The EV transition creates additional opportunities: battery assembly, power electronics, and EV-specific wiring harness demand create new component categories for which Ukraine's labour cost competitiveness and geographic position are structural advantages.

DIRECT MINING RECONSTRUCTION TOWARDS DOWNSTREAM PROCESSING, NOT RAW EXTRACTION

The investment implication of the mining trade analysis is unambiguous: building domestic mineral processing and refining capacity - for iron ore, titanium, lithium, manganese, and critical minerals - would shift Ukrainian exports up the value chain toward the EU markets where Ukraine already has competitive footing, while simultaneously building the supply chain relationships that European industrial buyers require. Reconstruction investment in mining should be conditioned on downstream integration: raw ore restoration without processing capacity investment perpetuates the commodity trap and foregoes the strategic value of Ukraine's critical mineral endowment at precisely the moment when European demand for secure, proximate critical mineral supply chains is highest.

BUILD COMMERCIAL TECHNOLOGY TRANSFER INFRASTRUCTURE ACROSS PRIORITY SECTORS

The gap between Ukraine's research depth and its commercial technology output is a structural problem that requires institutional solutions. Priority investments should include: university-industry technology transfer offices with the mandate and capacity to commercialise research outputs; EU-standard intellectual property protection frameworks; joint venture structures with Western industrial partners in AI, cybersecurity, and medtech that are designed to generate co-inventions anchored in Ukraine's IP system; and expanded participation in EU joint technology initiatives that link Ukrainian research institutions directly to European industrial R&D programmes.

MODERNISE TRADITIONAL SECTORS AS THE BACKBONE OF INCLUSIVE RECOVERY

Wood processing, textiles, and agritech are where Ukraine has a broad productive base, a strong regional employment footprint, and a deep existing EU market integration. These sectors should be upgraded, not just maintained. Three priorities: embed digital and AI capabilities into production (precision farming, digital design in textiles, traceability in forestry) to convert Ukraine's IT talent base into productivity gains where employment is actually concentrated; redirect research collaboration toward underweight innovation partners; and align production with EU best practices on sustainability certification, deforestation due diligence, and chemical compliance, drawing on the pathways set out in the companion CEPS-UNIDO report (Plantera, F., Griffith, J., Kyosovska, N. 2026).

DEVELOP A SELECTIVE SCIENTIFIC PARTNERSHIP STRATEGY TARGETING SOUTH KOREA, JAPAN, AND AUSTRALIA

The systematic under-representation of East Asian partners in Ukraine's scientific collaboration networks, in sectors like medtech, semiconductors, robotics, and nuclear where South Korea, Japan, and Australia are global leaders, represents a set of bilateral opportunities that do not raise the security concerns associated with China engagement. International institutions could help jointly develop a selective bilateral scientific partnership programme targeting these countries, structured around sector-specific joint research programmes, researcher exchange schemes, and joint publication incentives.

Policy Recommendations

DEVELOP A COMPREHENSIVE US COMMERCIAL ENGAGEMENT STRATEGY

The gap between the centrality of the US as Ukraine's most consequential security partner and the near-absence of bilateral commercial relationships – 3.6% of imports, 5.2% of exports – is both an economic inefficiency and a political vulnerability. A dedicated US-Ukraine commercial partnership programme, covering investment facilitation, procurement relationships in defencetech and cybersecurity, and agricultural trade expansion, would create the domestic commercial constituency in the US that makes its political support for Ukraine structurally fragile. Ukraine's cyber expertise, defence innovation, and agricultural capacity all represent sectors in which bilateral commercial logic is strong but where institutional channels are absent.

USE GREENTECH RECONSTRUCTION TO BUILD UKRAINIAN MANUFACTURING CAPACITY, NOT IMPORT DEPENDENCY

The current greentech import-to-export ratio reflects the limit of domestic manufacturing base for the green transition. Reconstruction presents the opportunity to source less components from China and Türkiye and reconstruction investment to build Ukrainian manufacturing capacity in selected green technology product categories. The European Net Zero Industry Act, which targets 40% of clean technology manufactured in Europe by 2030, creates a policy context in which Ukrainian greentech manufacturing, inside the EU accession framework, could qualify as European capacity. The goal would be to identify two or three product categories where Ukrainian manufacturing could realistically become competitive within five years and structuring joint EU-Ukraine investment programmes around those niches. This is more strategically valuable than broad green technology investment spread across all categories.

USE RECONSTRUCTION TO POSITION UKRAINE – AND KYIV IN PARTICULAR – AS A STRATEGIC NODE IN THE EU ECONOMY

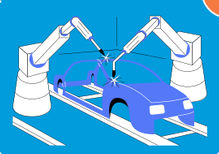
The recommendations above share a common logic: reconstruction is not a return to the pre-war structure but a one-time opportunity to reset Ukraine's position in European value chains on terms that match the obligations and opportunities of EU accession. The trade, research, and patent data converge on the same conclusion: Ukraine is already structurally European, but its integration is concentrated in low-complexity sectors, anchored in a narrow set of proximate partners, and underleveraged in the innovation-intensive activities where European demand is growing fastest. Energy reconstruction builds the physical layer for a digital and AI-enabled economy; downstream processing in mining captures critical mineral value where the EU urgently needs secure supply; modernised traditional sectors raise productivity where employment is concentrated; dual-use industrial capacity converts wartime knowledge into civilian European markets; and commercial technology transfer infrastructure contributes to close the gap between Ukraine's strong research base and its thin innovation output. Taken together, these tracks position Kyiv as a regional hub for innovation, advanced manufacturing, and knowledge-intensive services – and they make accession not just a political destination but also an industrial transformation. The reconstruction window is short, the investment flows are large, and the institutional moment is unusually permissive. Using it well is the difference between Ukraine acceding to the EU as a peripheral economy and acceding as a strategic contributor to European competitiveness.

Conclusion

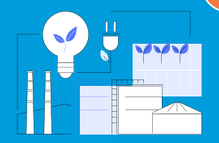
The evidence in this report points to a single strategic imperative: Ukraine's reconstruction should be designed not to restore the pre-war economic structure but to reposition Ukraine higher in European and global value chains while reducing the most consequential strategic dependencies. The policy agenda that follows from the three-layer analysis is therefore a sequencing agenda.

If implemented as a coherent package, these recommendations turn reconstruction finance into a mechanism for durable integration: not only deeper trade with Europe, but deeper capability, stronger innovation partnerships, and an industrial base that is resilient under geopolitical stress. The strategic question is no longer whether Ukraine integrates with Europe (the trade, research, and patent data confirm this is already the structural reality) but on what terms, at what level of complexity, and with what degree of resilience. Reconstruction is the lever that decides the answer.

1 **First, rebuild the enabling foundations that determine what can scale: energy, logistics, and EU-aligned standards, testing, and certification capacity. Without these, no other upgrading agenda is operationally viable.**



2 **Second, concentrate investment and partnership-building in the sectors where two-way integration and upgrading are already plausible – automotive, advanced manufacturing, aerospace maintenance, chemicals, medtech, and digital security – rather than spreading reconstruction resources thinly across all 25 strategic industries.**



3 **Third, use accession obligations as a lever to accelerate quality, interoperability, and decarbonisation rather than as a compliance cost absorbed at the end of the process; the sectoral analysis shows repeatedly that EU regulatory alignment, when built into reconstruction investment from the start, is a source of competitive advantage rather than a burden.**

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INTERACTIVE VISUALISATIONS

This report is accompanied by a comprehensive suite of interactive visualisations enabling deeper exploration of the data, which are accessible through the following general link and the specific links listed below.

Type	Data Source	Hyperlink
Domain space	Openalex	https://www.paballand.com/ceps/unido-2/openalex.html
Domain space	Regpat	https://www.paballand.com/ceps/unido-2/regpat.html
Sankey	Trade	https://www.paballand.com/ceps/unido-2/sankey/eu.html
Sankey	Trade	https://www.paballand.com/ceps/unido-2/sankey/eu_countries.html
Sankey	Trade	https://www.paballand.com/ceps/unido-2/sankey/domains.html
Sankey	Trade	https://www.paballand.com/ceps/unido-2/sankey/aerospace.html
Sankey	Trade	https://www.paballand.com/ceps/unido-2/sankey/agritech.html
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Sankey	Regpat	https://www.paballand.com/ceps/unido-2/sankey/regpat/textiles-eu_countries.html
Sankey	Regpat	https://www.paballand.com/ceps/unido-2/sankey/regpat/unmanned_autonomous_systems-eu_countries.html
Sankey	Regpat	https://www.paballand.com/ceps/unido-2/sankey/regpat/wood_processing-eu_countries.html
Networks	Openalex	https://www.paballand.com/ceps/unido-2/openalex/aerospace.html
Networks	Openalex	https://www.paballand.com/ceps/unido-2/openalex/agritech.html
Networks	Openalex	https://www.paballand.com/ceps/unido-2/openalex/artificial-intelligence.html
Networks	Openalex	https://www.paballand.com/ceps/unido-2/openalex/automotive.html
Networks	Openalex	https://www.paballand.com/ceps/unido-2/openalex/biotech.html
Networks	Openalex	https://www.paballand.com/ceps/unido-2/openalex/chemical-engineering.html
Networks	Openalex	https://www.paballand.com/ceps/unido-2/openalex/coal.html
Networks	Openalex	https://www.paballand.com/ceps/unido-2/openalex/defensetech.html
Networks	Openalex	https://www.paballand.com/ceps/unido-2/openalex/edtech.html
Networks	Openalex	https://www.paballand.com/ceps/unido-2/openalex/energy.html
Networks	Openalex	https://www.paballand.com/ceps/unido-2/openalex/extended-reality.html
Networks	Openalex	https://www.paballand.com/ceps/unido-2/openalex/govtech.html
Networks	Openalex	https://www.paballand.com/ceps/unido-2/openalex/greentech.html
Networks	Openalex	https://www.paballand.com/ceps/unido-2/openalex/medtech.html
Networks	Openalex	https://www.paballand.com/ceps/unido-2/openalex/metallurgy.html
Networks	Openalex	https://www.paballand.com/ceps/unido-2/openalex/mining.html

Type	Data Source	Hyperlink
Networks	Openalex	https://www.paballand.com/ceps/unido-2/openalex/nuclear.html
Networks	Openalex	https://www.paballand.com/ceps/unido-2/openalex/railway.html
Networks	Openalex	https://www.paballand.com/ceps/unido-2/openalex/robotics.html
Networks	Openalex	https://www.paballand.com/ceps/unido-2/openalex/secure-cyberspace.html
Networks	Openalex	https://www.paballand.com/ceps/unido-2/openalex/semiconductors.html
Networks	Openalex	https://www.paballand.com/ceps/unido-2/openalex/shipbuilding.html
Networks	Openalex	https://www.paballand.com/ceps/unido-2/openalex/textiles.html
Networks	Openalex	https://www.paballand.com/ceps/unido-2/openalex/unmanned-&-autonomous-systems.html
Networks	Openalex	https://www.paballand.com/ceps/unido-2/openalex/wood-processing.html
Networks	Regpat	https://www.paballand.com/ceps/unido-2/regpat/aerospace.html
Networks	Regpat	https://www.paballand.com/ceps/unido-2/regpat/agritech.html
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Networks	Trade	https://www.paballand.com/ceps/unido-2/trade/aerospace.html
Networks	Trade	https://www.paballand.com/ceps/unido-2/trade/agritech.html

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Networks	Trade	https://www.paballand.com/ceps/unido-2/trade/coal.html
Networks	Trade	https://www.paballand.com/ceps/unido-2/trade/defensetech.html
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Networks	Trade	https://www.paballand.com/ceps/unido-2/trade/mining.html
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Networks	Trade	https://www.paballand.com/ceps/unido-2/trade/semiconductors.html
Networks	Trade	https://www.paballand.com/ceps/unido-2/trade/shipbuilding.html
Networks	Trade	https://www.paballand.com/ceps/unido-2/trade/textiles.html
Networks	Trade	https://www.paballand.com/ceps/unido-2/trade/ukraine_exports_chart.html
Networks	Trade	https://www.paballand.com/ceps/unido-2/trade/ukraine.html
Networks	Trade	https://www.paballand.com/ceps/unido-2/trade/unmanned__autonomous_systems.html
Networks	Trade	https://www.paballand.com/ceps/unido-2/trade/wood_processing.html

LIST OF FIGURES

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