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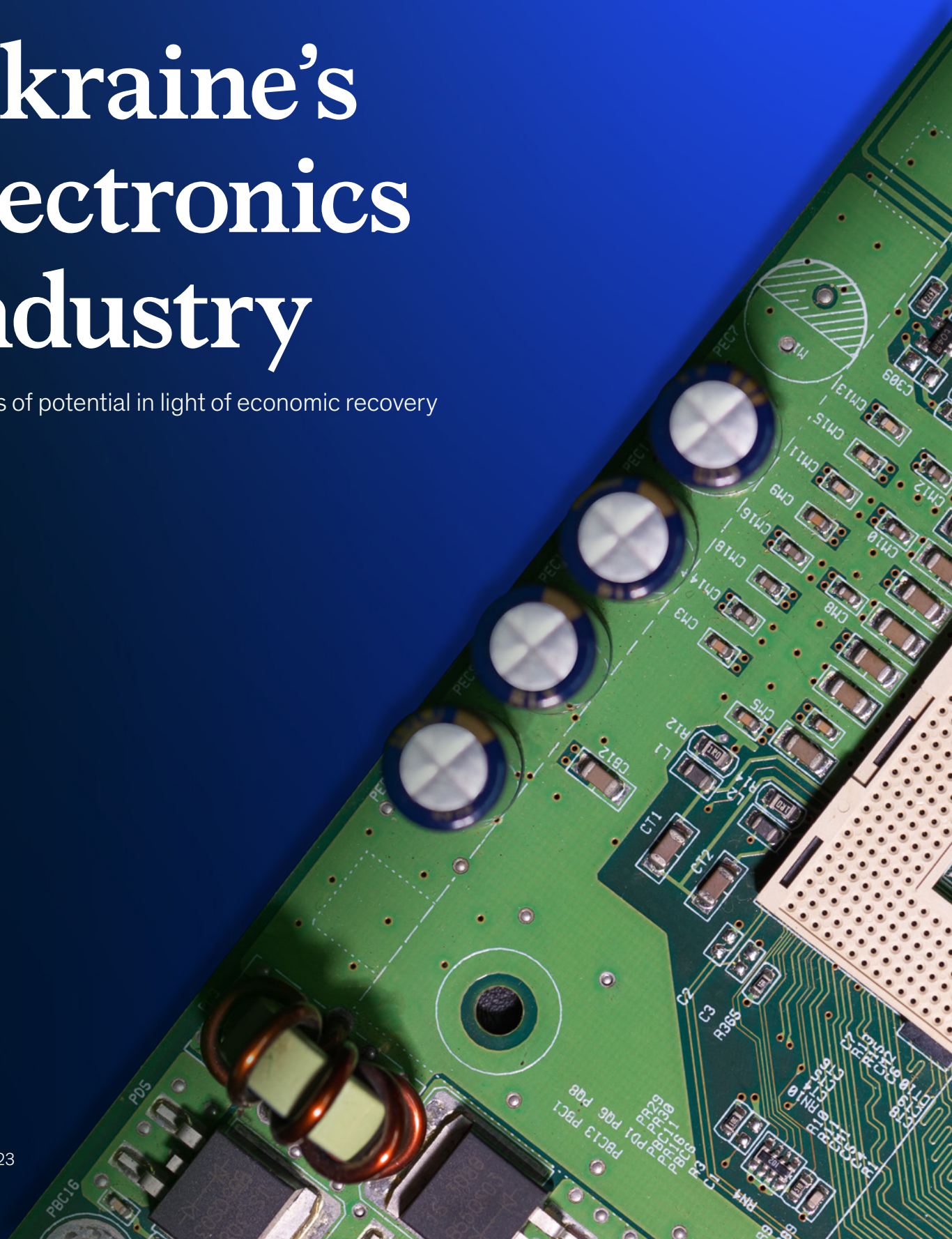
Ukraine's electronics industry

Analysis of potential in light of economic recovery



August 2023

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As a sector, global electronics is poised for a decade of growth, and Europe has an opportunity to reposition itself closer to the center of the industry. The associated growth in the upstream demand for semiconductors will bring along with it a need for greater supply of downstream components and platforms.

Ukraine has been and continues to be a "home" for several sectors. In addition to software and IT services, several companies from the electronics value chain have established research centers and manufacturing facilities in Ukraine, and several are in operation today.

In this analysis, we look into the areas of the electronics value chain that are in high demand/have sourcing diversification needs, the typical investment location selection criteria for electronics players, and how Ukraine performs against these criteria. In our analysis, we draw upon both our detailed data analyses of country-level competitiveness across cost and strategy dimensions as well as our interviews with and survey of electronics leaders.

As demand for semiconductors is expected to soar, demand for adjacent electronics components is likely to follow

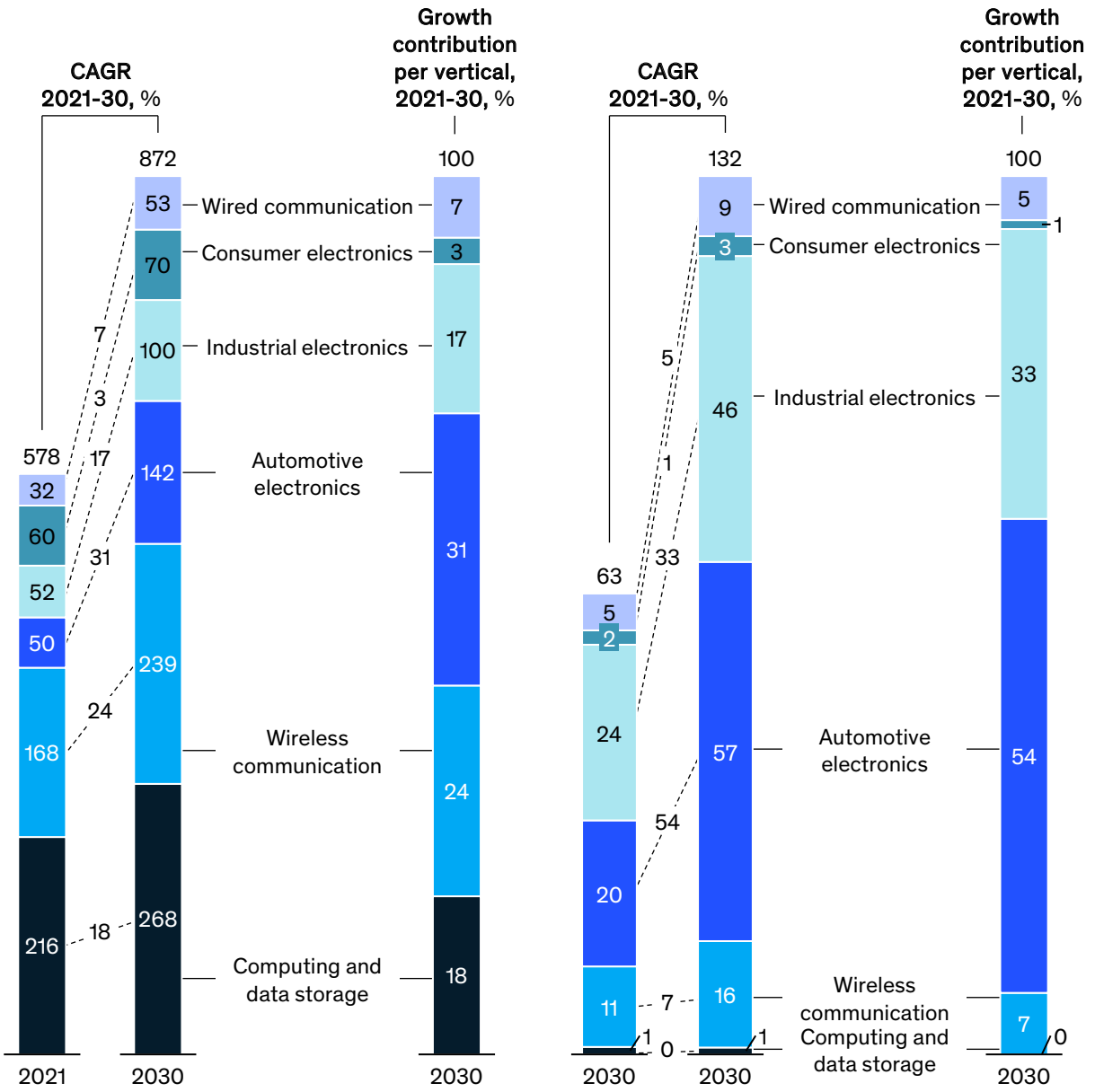
Industries are digitalizing rapidly. Products that once featured only the most basic of electronics are now equipped with high-processing onboard computers, and the command center of these computers is the semiconductor. With a "chip" in everything from handheld communications devices and medical devices to household appliances and vehicles, the demand for semiconductors is rising accordingly. By 2030, the value of the global semiconductor industry is currently estimated to be around USD 900 billion[1] (Figure 1).

The automotive, industrial, computing/data storage, and wireless communication industries are expected to account for about 90% of the semiconductor industry's global growth until then. The value of semiconductors in the automotive industry, in particular, is projected to increase threefold, driven by trends such as autonomous driving and e-mobility. The impact is most pronounced in the EMEA region, where the automotive and industrial electronics sectors alone are projected to contribute approximately 80% of semiconductor sales and account for around 90% of the overall growth until 2030.

[1] The semiconductor decade: A trillion-dollar industry, https://www.mckinsey.com/industries/semiconductors/our-insights/the-semiconductor-decade-a-trillion-dollar-industry

Figure 1

Growth in the global semiconductor market is expected to be driven by the automotive, industrial, computing/data storage, and wireless industries



Note: Figures are approximate; Omdia release Q1 2023 incl. McKinsey forecast for 2027-30

Just to meet the 2030 demand for semiconductors from Europe alone, the equivalent of 37 additional front-end wafer fabs is needed.[2] To support such an expansion of these (often billion-dollar) centerpieces of the semiconductor value chain (regardless of their actual realization in Europe), adjacent value chain segments in the form of back-end facilities, tool and material supply, EMS service, etc. also need to keep up with the growth to unleash the overall industry expansion (Figure 2; also see text box). With typical investment sums much smaller than those required for fabs, these downstream segments can mark the focus areas for a country' or region's targeted expansion in the broader electronics industry and hence are studied in this white paper.

Beyond additional capacity, the electronics industry would also benefit from a more geographically distributed supply chain. The COVID-19 pandemic, other recent natural disasters, and rising geopolitical tension revealed the vulnerability of the current semiconductor supply chain's high concentration in Asia and made it clear that bottlenecks or other disruptions in one part of the chain can disrupt the entire industry.

Relevant elements of the electronics value chain – glossary of key terms

Note: The semiconductor and the electronics industry are closely related but distinct sectors. The former focuses on the (integrated circuit) design, development, manufacturing, and packaging (for example, in foundries) of semiconductor wafers and chips. The latter encompasses a broader set of production as well as design and sales activities related to finished (for example, consumer, telecommunication, medical) products that utilize electronic components, including semiconductor chipsets.

OSAT/IDM back end: Companies that provide packaging and testing services to semiconductor manufacturers – these companies take bare chips and convert them into a final product by bonding the chip to a substrate, adding wire bonds, and encapsulating the package in a protective material.

Passive components: Manufacturing components related to PCB assembly, such as capacitors, inductors, and resistors.

EMS/ODMs: EMS companies offer a wide range of services, including PCB assembly, while ODMs design and manufacture their own products, which are subsequently sold to other companies.

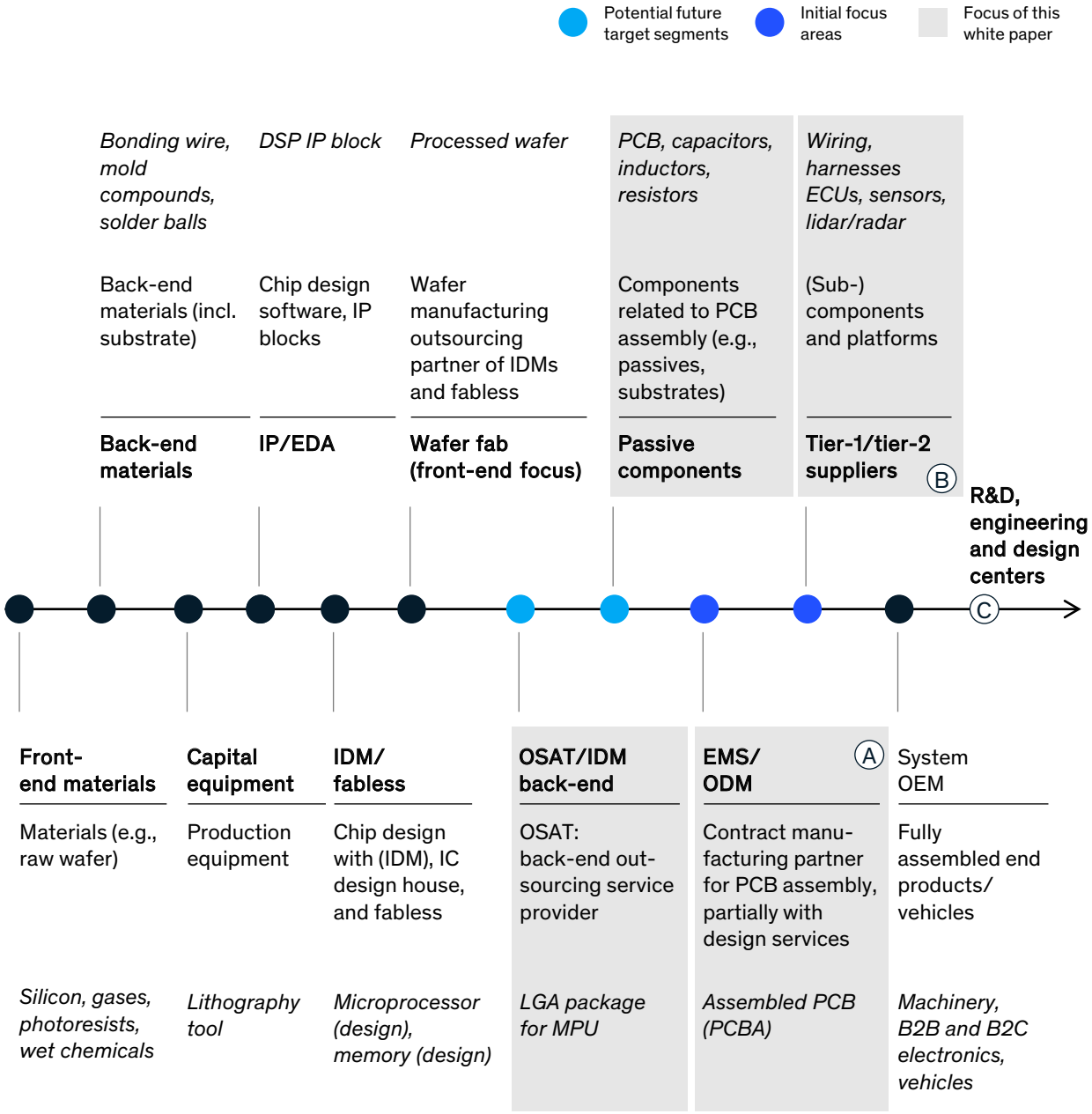
Tier-one and tier-two suppliers: Suppliers of electronic components and platforms to OEMs, such as those in the automotive industry – these components could be wiring, harnesses, sensors, and other electronic components.

R&D, engineering, and design centers: R&D engineering and design centers drive innovation and develop advanced technologies that enhance the performance and capabilities across all segments. They also facilitate the flow of knowledge and expertise across the segments, ultimately shaping the evolution of the entire value chain.

[2] Semiconductor Crisis – Requirements for Future Relevance, Competence, and Resilience for Europe, https://www.vda.de/en/news/publications/publication/semiconductor-crisis

Figure 2

The assessment's focus is on four parts of the electronics value chain



Source: McKinsey

Note: DSP – digital signal processor; EDA – electronic design automation; EMS – electronics manufacturing services (electronics contract manufacturer plus value-added services); IDM – integrated device manufacturer; IP – intellectual property; LGA – land grid array; MPU – microprocessor unit; ODM – original design manufacturer. OSAT – outsourced semiconductor assembly and test; PCB – printed circuit board

Analysis along key competitive factors suggests that expanding electronics in Ukraine could benefit individual players and the industry in Europe as a whole

In determining the feasibility of a growing role for any country or region in meeting the demand for semiconductors – specifically, the expansion of electronics players into a particular country or region – there are a multitude of factors to consider. These factors can be broadly divided into three groups:

Macroeconomic factors include a country's or region's GDP growth, current levels of foreign direct investment, inflation rate, export/import activity, demographics, political stability, tax policies, infrastructure development, and workforce availability.

Cost competitiveness factors include country- or region-specific logistics, labor, capex, finance, and utilities cost. The degree to which the government would support the expansion into that country or region – for example, subsidies for companies seeking to establish or grow their presence in another country – is also critical.

Strategic competitiveness factors include the technical education and capabilities of the talent pool, the existence of an ecosystem that would facilitate the expansion, logistics infrastructure, ease of doing business, local market size and growth, access to R&D and innovation, access to local raw materials, and the rule of law and corporate conduct.

Additionally, electronics players' company-specific factors – such as specific supply/demand situations, company targets in terms of supply chain resilience, value chain integration, proximity to demand centers, product portfolio and its alignment with the local market demands, existing partnerships or collaborations with local companies, and strategic risk appetite – will also play a role in the decision-making process. Therefore, a thorough consideration of the three broad categories described above along with company-specific factors is essential in determining the feasibility and potential success of an electronics player's expansion into any country or region.

With these three factors in mind, we sought to assess the feasibility of European electronics companies either establishing operations in Ukraine or – for the ones who already have a footprint in Ukraine – expanding their activities there in an assumed future, in a more stable security policy situation. The subsequent analyses are thus assuming a post-war situation in Ukraine. While we cannot anticipate how the current situation and risks (e.g., geopolitical-, military-, economic-, and cybersecurity risks) will evolve and how a post-war situation might look like in detail, we focused in this analysis on objectively quantifiable factors and input from experts with experience in running significant operations in Ukraine and other CEE countries.

Against this backdrop, we conducted this assessment in two ways. First, we engaged the decision makers of more than two dozen electronics companies to understand what was most important to them when thinking about expanding in other regions, in general, and their perceptions of Ukraine, in particular. Second, we took a close look at multiple data sets and conducted analyses to objectively determine Ukraine's performance along several dimensions across these three factors. For this more quantitative part, we look at Ukraine in the context of the broader Central and Eastern Europe (CEE), benchmarking Ukraine against CEE averages. Together, the insights are meant to reveal any synergetic opportunities for the expansion of the European electronics industry in the region and Ukraine's economic recovery.

At this point, some of our readers may note the conspicuous absence of conversations that look at the geopolitics of Ukraine beyond the current war. Namely, even after the current conflict is over, what role might continued threats — both militarily and from a cybersecurity perspective — play in electronics players' expansion decision making? It is true that Ukraine may still be vulnerable to Russia's long-term vision of expansion after the current war. It is also true that Ukraine is a popular target of Russian hackers. Our quantitative analyses, however, rely on our ability to make "apples to apples" comparisons of CEE countries using existing and widely agreed upon indexes

Figure 3

CxO survey and interviews identify opportunities and challenges for Ukraine's electronics industry

Key survey and interview facts

>25

CxO/executive participants from **companies across the electronics value chain**[1]

~40%

respondents have already invested in **Ukraine's electronics industry**

~75%

of existing investors seriously consider **further investments**

~50%

higher likelihood of subsequent investment vs. 1st investment

~75%

see **small**-scale (USD 25 mn) **manufacturing sites** and **R&D centers** as most likely investment scenarios for post-war phase

Opportunities

~80%

see highly motivated **talent pool** and low **labor cost** as key drivers for investments

~60%

confirmed **technical education and capabilities** on par with CEE[2] peers

~50%

considered **EMS, tier-1 (automotive) suppliers,** and **IT outsourcing** as **highest-potential** electronics value chain segment for further investments

Challenges

~60%

perceive substandard **corporate conduct/rule of law, low "ease of doing business"** and cumbersome **customs clearance** as main disadvantages

~40%

consider long-term **geopolitical stability** (incl. cybersecurity threats), **currency exchange rate fluctuations, missing expertise** in broader **electronics engineering (non-software)** and **advanced manufacturing** for larger value-chain coverage as further **pain points**

1. Countries considered: Hungary, Serbia, Poland, Romania, Bulgaria, Slovakia, Czech Republic

Source: Survey results; CxO interviews

and rankings. This is why we focus on cost factors, such as labor and utilities, and strategic factors, such as local market size and logistics infrastructure. It is also important to note that on the qualitative side — i.e., our conversations with electronics industry leaders — neither the idea of additional military conflicts in the future nor the reality of cybersecurity threats today were mentioned in their considerations to launch or expand operations within Ukraine.

We engaged more than two dozen electronics industry leaders in a combination of one-on-one conversations and a survey. One of the biggest takeaways, described in Figure 3, is that leaders generally perceive Ukraine as a place that makes sense for them to conduct business with, two-thirds seeing a place for their companies in Ukraine. Most notable is the response we received from electronics leaders already doing business in Ukraine, three-quarters of whom say they are considering increasing the investment they have already made in Ukraine. This sentiment aligns with the results of an earlier survey of more than 100 leaders of international companies across multiple industries with operations in Ukraine, more than 60% of whom said they would

continue to invest in Ukraine despite the disruptions of the war.[3] Additionally, three-quarters see small-scale manufacturing sites and R&D centers as their most likely future investments.

Leaders pointed first to the country's skilled and cost-competitive workforce as main drivers of their current satisfaction and interest in further expansion. In addition, the interviewed electronics leaders generally find the Ukrainian talent with whom they work to be highly motivated and committed to their jobs.

Ukraine's performance on macroeconomic factors

Ukraine has the largest population (pre-war level around 41.2 million) and the largest available workforce (17.3 million) in the CEE region. The war has disrupted this workforce profoundly, including an unemployment rate that rose from around 10% to 35% in 2022, suggesting (and confirmed by interviewed workforce experts) that a post-war Ukraine will likely have significant availability of highly motivated, skilled local talent. This same logic holds true for another aspect of workforce disruption: displacement. The war has led to approximately 4 to 5 million Ukrainians leaving the country,[4] though more than 70% of whom plan to return after the end of the war. Another 6 to 7 million are internally displaced to the central and western parts of Ukraine, which are predominant locations for export-oriented electronics companies.

With a CAGR of around 15% (between 2% and 4% real GDP growth after adjustment for inflation), Ukraine showed promising economic growth over the five years before the war, but the conflict led to a 35% drop in GDP in 2022. Disrupted hryvnia (UAH) exchange rates present an opportunity for exporters, particularly when receiving payment in foreign currencies like the dollar (USD) or euro (EUR).

Ukraine's performance on cost factors

Our analyses of the wider period of 2018 to 2023 saw Ukraine outperforming CEE peers on cost. Ukraine's strength in this category is mainly driven by the availability of a highly skilled workforce at a cost that is very competitive within the CEE region. For the electronics leaders we interviewed, the cost of labor is the most important factor when considering expanding into other regions (Figure 4), and in this category, Ukraine delivers. Specifically, Ukraine offers a labor cost advantage of 55% to 65% for both skilled and unskilled workers compared to the CEE average.[5] For electronics engineers, Ukraine's hourly wages are 46% lower than the CEE average. Additionally, the cost of utilities in Ukraine, such as electricity, gas, and water, are around 50% to 70% lower than the European average.

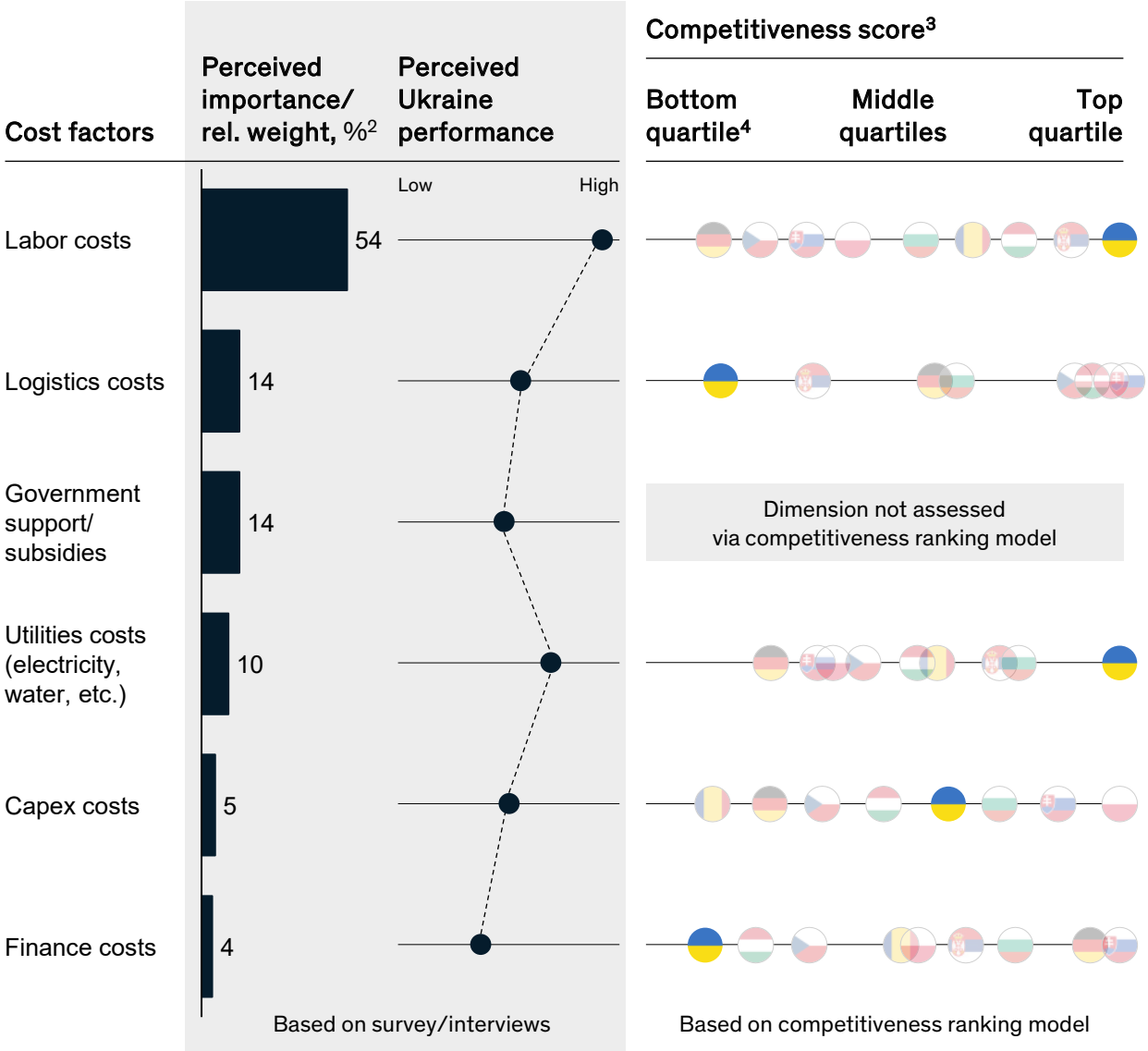
However, Ukraine struggles in the area of logistics with high customs fees, the sheer size of the country and large distances to customers, as well as an infrastructure which – even pre-war and now all the more due to war damage – shows varying quality, driving costs, and inefficiencies. This is important because electronics industry leaders told us that logistics is their second-most important consideration regarding regional expansion. Tied for second in the cost competitiveness category is government support/subsidies. Most of the company leaders we spoke to, however, reported that their companies operate successfully irrespective of financial incentives from the Ukrainian government. Finally, finance costs are considered rather unfavorable in Ukraine; however, the surveyed leaders considered this as less important largely because financing is anticipated to be secured with banks outside of Ukraine.

Companies planning entry into Ukraine or increase investments into their existing business there may also consider the country's historical and longer-term performance over the chosen period in our assessment, to avoid decision making guided exclusively by war-time data.

[3] European Business Association Survey; more than 100 CEO participants as of H2 2022; conducted Q1 2023
[4] United Nations High Commissioner for Refugees, Operational Data Portal
[5] fDi Benchmark, a service from the Financial Times Limited 2021 – fDi Intelligence based on Willis Towers Watson Global 50 Remuneration Planning Report

Figure 4

Ukraine is strong on key cost metrics in labor and utilities, yet logistics and financing cost gaps are substantial



1. Data based on aggregate sources from 2018-23
2. Relative weights are based on the perceived importance of each criteria for the investment decision-making process and are derived as average values provided by the interviewed companies, which are currently operating in Ukraine or contemplating an investment there
3. Relative competitiveness normalized to displayed country list; displayed values are weighted averages across multiple indicators within given subfactor
4. Quartiles divide a distribution of values into four equal parts

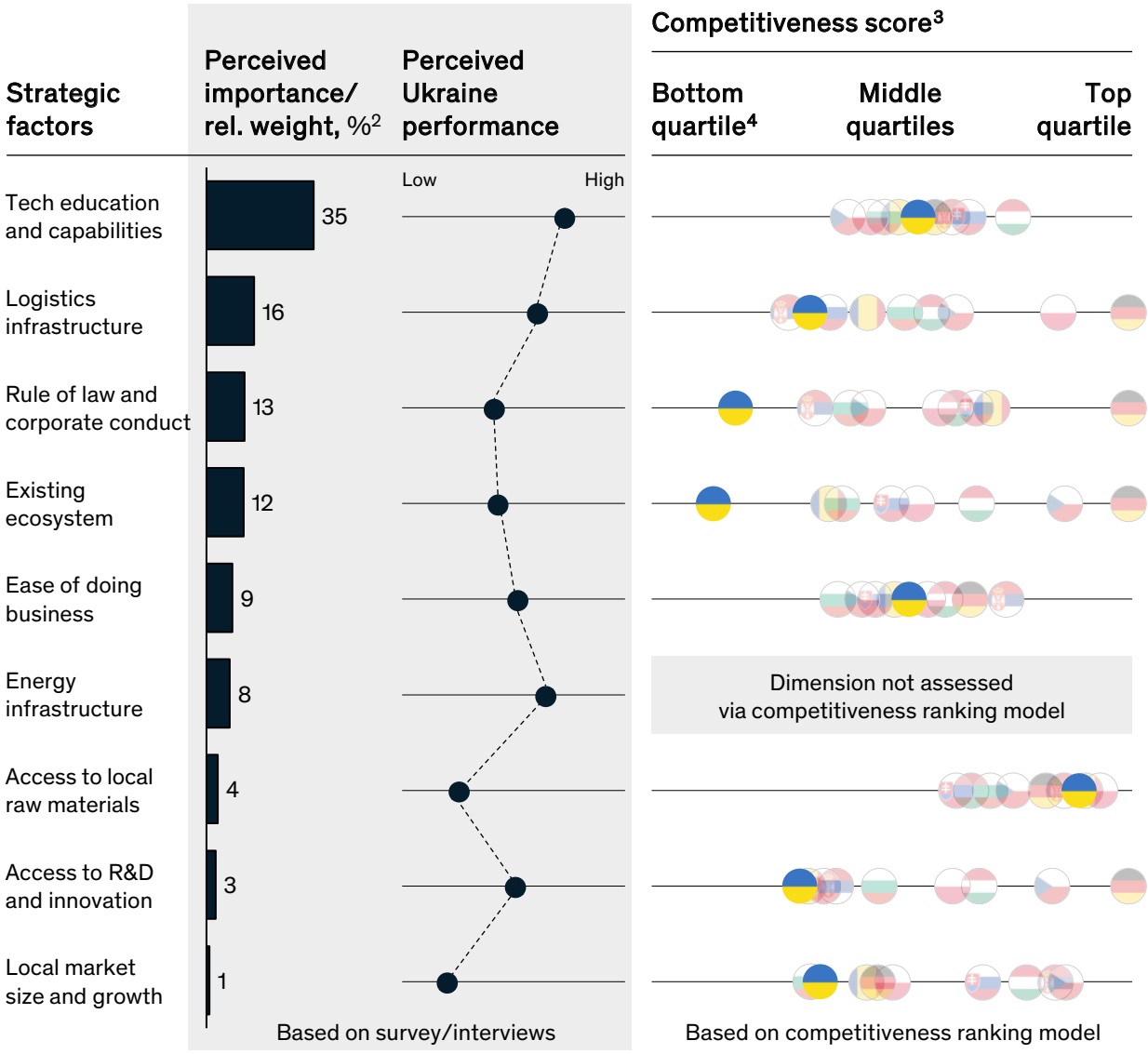
Source: Survey results; CxO interviews; World Bank: World Development Indicators (WDI); Comparative Industry Service (CIS) - ISIC Revision 4, Annual; Global Commodities Summary; The Global Competitiveness Report; Global Innovation Index; Global Network Readiness Index; McKinsey Economic Development Analytics solutions; team analysis

Ukraine's performance on strategic factors

Based on the research of the strategic competitiveness factors, Ukraine demonstrates a reasonable level of performance on key metrics such as technical skills of the workforce. However, there are still some areas (corporate conduct, local ecosystem) where it lags behind (Figure 5).

Figure 5

Ukraine's strategic performance is mostly in central quartiles (e.g., workforce skills) but shows a gap in corporate conduct and local ecosystem



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When considering potential investments in Ukraine, investors prioritize three factors that have a significant impact on the country's strategic competitiveness:

Technical education and capabilities. While the price tag of labor is certainly an important consideration in any potential regional expansion from a cost perspective, the capabilities of that workforce are extremely important from a strategic perspective. In fact, the electronics leaders we interviewed noted that the education and capabilities level of the local workforce is the most important strategic factor when looking into investing in the CEE region and particularly in Ukraine. With a Skills score of 69.9 in the 2020 Global Competitiveness Index 2020 and a Talent Competitiveness Index score of 46 for the CEE region in 2021, Ukraine is competitive in the region.

What is more, with over 130,000 engineering graduates annually, including approximately 12,000 in the IT field and more than 6,500 in electronics engineering,[6] Ukraine's technical education system offers a robust pipeline of talent for businesses to tap into. However, while Ukraine's IT engineers have proven to be of very high quality, our interviews with industry leaders suggest that the quality of hardware and electrical engineering education has some gaps that need to be addressed. Overall, Ukraine's technical education system has a strong potential to drive the country's economic growth by providing a robust talent pool for businesses.

As discussed earlier, several of the industry leaders we interviewed with a presence in Ukraine had a very positive attitude towards the Ukrainian labor force (seconded by the highest perceived performance score on workforce skill/quality), highlighting that their Ukrainian employees are greatly committed, willing to learn, and motivated. It was also noted that the business culture in Ukraine makes it easy for Ukrainian employees to integrate into, collaborate with, and work efficiently within a multinational company.

Logistics infrastructure. The (pre-war) transport sector considered here is a significant contributor to Ukraine's economy, accounting for 6.4% of GDP and 7% of total employment. The country's extensive railway network spans over 20,000 km, with 45% of the track electrified, making it a crucial transit corridor between Europe, Asia, and the Middle East. Rail transport is a vital mode of transport for Ukraine, with around 40% of goods transported by rail, compared to, for example, only 10% in Poland. Ukraine also boasts a vast highway network of 170,000 km, numerous sea and river ports, and 23 airports, including four international ones. The war has certainly damaged Ukraine's transport infrastructure, but the country's investment in a vast, multimodal transport network points to its importance as a government strategy and the likelihood that its restoration will be a post-war priority.

There are, however, also challenges in Ukraine's logistics infrastructure. First, the quality of infrastructure across regions is not consistent, with the Western regions up to Kyiv being more developed than the East. Secondly, the inefficiencies at border crossings, and the significant difference in rail gauge size (1,520 mm vs. 1,435 mm in most EU countries) compared to its European counterparts, have hindered logistics efficiency. The Ukrainian government has plans to construct European standard-gauge lines,[7] but the current infrastructure still falls behind CEE peers. The war has already caused over USD 35 billion in damage to transportation infrastructure, making it challenging to restore the logistics infrastructure to its former state. In addition to these challenges, our CxO interviews/survey suggest inefficiencies in Ukraine's customs procedures, namely low throughput and long processing times. These issues further contribute to the country's lower strategic competitiveness ranking compared to its CEE peers.

[6] The Global Talent Competitiveness Index 2021 report; State Statistics Services of Ukraine; insead.edu; IMD World Competitiveness Center

[7] Rzeczpospolita, "Ukraina chce wybudować europejskie tory" as of March 3, 2023 (https://www.rp.pl/transport/art38059971-ukraina-chce-wybudowac-europejskie-tory, "Ukraine wants to build European tracks")

Rule of law and corporate conduct. Similar to the perception of logistics in Ukraine, the leaders we engaged have a picture of Ukraine's frameworks and conduct around business that might actually be more favorable than our objective data analysis suggests. This may be explained by a nuanced reality described by Western players already established in Ukraine. Namely, while companies may have experienced initial challenges from local authorities, those we spoke to indicated that strict adherence to their companies' policies on transparency and compliance quickly led to an environment in which these challenges ceased to exist. Together, these three factors are considered twice as important by electronics leaders than the other six strategic factors displayed above combined. Ultimately, each investor will make a decision based on a range of company-specific factors.

Ukraine is already positioned across three focus segments of the electronics value chain in the short term

Based on the strengths and gaps we have identified in our data analyses as well as those highlighted in the surveys and interviews, we assessed the specific requirements of each part of the value chain to determine which segments could be well suited for expansion into Ukraine. Specifically, the players and components along the back end of the value chain that already have an existing footprint in Ukraine – EMS/ODM, tier-one and tier-two suppliers, and R&D and engineering centers (A to C in Figure 2) – could examine opportunities for expansion in the near term. The preceding two segments of the value chain (IDM/OSAT/back-end and passive components) are likely out of scope for the time being. This is largely because of the high initial capital expenditure required, the long distance to the end customers, and the high dependance on government subsidies. In addition, the passive component players would seek competition in a fairly consolidated current market, potentially making a new entrance less attractive. However, less automated manufacturing in OSAT/back-end and passive components segments may be on the longer-term horizon. This may be the case once initial investments in the above-mentioned focus areas (A to C) stimulate an expansion up and down the value chain. If Ukraine is granted EU membership, additional new opportunities could open up, including EU market access and sector subsidies.

A) Ukraine's prospects and challenges regarding EMS/ODMs

EMS focuses on manufacturing services, while joint development manufacturers (JDMs) specialize in collaborative product design. ODMs handle both design and manufacturing, selling products under their customers' brand names. It's worth noting that many large contract manufacturers offer both EMS and ODM services, adapting their capabilities to meet the specific needs of their customers and industries.

Ukraine presents promising opportunities for investments in EMS and ODMs due to its cost-competitive workforce, skilled labor availability, local-for-local demand, and low utility costs. The global EMS and ODM markets have experienced strong growth, reaching over USD 680 billion in revenue in 2021 and a CAGR of +10% from 2016 to 2021, with the EMS market accounting for 80% of the total EMS/JDM/ODM revenue.

The EMS and ODM markets are highly concentrated, with the top players holding significant market shares. In the ODM market, the top five players control 90% of the market, but none of them has a presence in Ukraine. On the other hand, in the EMS market, the top five players capture around 65% of the market, and two out of the five have established their footprint in Ukraine.

In considering which aspects of EMS to expand into Ukraine, we looked at Ukraine's current capacity and likely performance along two dimensions: product volume and product complexity. Our assessment showed that today, Ukraine is an attractive option as a site for low-complexity products of both high and low volumes. This would include product groups such as household appliances and automotive. High-complexity/low-volume products, such as robotics or medical devices, might be given second priority.

B) Ukraine's prospects and challenges regarding tier-one and tier-two suppliers

Ukraine, with its well-established presence of over 30 international tier-one and tier-two suppliers, presents promising expansion opportunities, particularly in the automotive sector. With a steady growth rate of 3.2% CAGR, Ukraine's automotive exports reached USD 1.6 billion in 2021, primarily driven by wiring and harnesses, which constitute the largest export category at 90%. This focus on low-complexity, labor-intensive products – heavily reliant on imports for necessary materials and partially due to logistical constraints for just-in-sequence (JIS) and just-in-time (JIT) deliveries to automotive OEMs around 1,000 km away – invites an optimization of the value chain to achieve leaner production, paired with streamlining transportation processes to yield significant benefits for automotive OEMs and supplier clusters. As the automotive electronics (and software) market is expected to grow at 5.5% per year through 2030[8] – with notable growth in ECU/DCU, power electronics, battery cells and housings, and sensors, among other areas – Ukraine may prepare a mid-term shift in line with the coming changes.

The potential for Ukraine to expand its involvement in the manufacturing of more complex products, such as battery cells, power electronics, and sensors, by capitalizing on its existing suppliers' ecosystem, warrants closer investigation. Ukraine possesses substantial reserves of graphite, aluminum, lithium, cobalt, and manganese, which can position the country favorably as the demand for electric vehicles continues to rise. This strategic move could allow Ukraine to tap into the opportunities presented by the growing automotive electronics market and further enhance its position in the industry.

C) Ukraine's prospects and challenges regarding R&D, engineering, and design centers

While our assessment is that the downstream activities of EMS/ODMs and tier-one and tier-two suppliers are viable options for Ukraine in the near term, a third focus area – R&D, engineering, and design centers – can build Ukraine's capacity for electronics activities further up the value chain. Serving as hubs for collaboration between academia, industry, and government, these centers have the ability to drive innovation via new technologies and improve existing product design and manufacturing processes. By developing local expertise, an investment in R&D, engineering, and design centers also positions Ukraine to become a center of higher-complexity electronics segments down the road. With lighthouse cases of university-to-R&D center talent funnels already demonstrated in Ukrainian academic clusters of electronics engineering, this type of investment also lends itself to the "smaller-scale investment" (typically less than USD 25 million) that survey and interview respondents pictured as the most likely investment scenario for the initial phase.

□□□

Growing global demand for electronics means a need for additional manufacturing capacity. For European players, a post-war Ukraine may offer an opportunity not only to build that capacity, but also to support a resilient supply chain by focusing on a region that is close to European markets. Furthermore, if electronics players choose to invest in Ukraine, they can tap into a skilled, available, and committed workforce.

[8] "Outlook on the automotive software and electronics market through 2030," McKinsey

Authors and contacts

Ondrej Burkacky, Senior Partner in McKinsey's Munich office

ondrej_burkacky@mckinsey.com

Katrin Mayer-Haug, Partner in McKinsey's Stuttgart office

katrin_mayer-haug@mckinsey.com

Oleksandr Kravchenko, Partner in McKinsey's Kyiv office

oleksandr_kravchenko@mckinsey.com

Vladimir Kamenskyi, Engagement Manager in McKinsey's Munich office

vladimir_kamenskyi@mckinsey.com

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