# Global Supply Chain Report

Summary

Electric Vehicle

Solar PV

Apparel

Medical Device

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# Contents

# Global Supply Chains in Transformation: Navigating Geopolitics, Technology, and Sustainability Across Four Strategic Industries

The global supply chain landscape is undergoing profound transformation driven by converging forces of geopolitical tensions, technological breakthroughs, environmental imperatives, and shifting industrial policies. An analysis of four critical industries—medical devices, apparel, solar photovoltaics, and electric vehicles—reveals both common patterns and sector-specific dynamics that are reshaping how and where products are manufactured, distributed, and consumed. These industries collectively represent trillions of dollars in annual global trade and employ hundreds of millions of workers, making their evolution critical to understanding the future of globalization itself.

## Current Supply Chain Footprints: Geography and Dominance

### *Medical Devices: A Triad of Power*

The global medical device market reached US$508.3 billion in 2024 and is projected to grow to US$717.4 billion by 2030, with a compound annual growth rate (CAGR) of 5.9%. The US dominates as both the largest market (US$186 billion in 2024) and a manufacturing powerhouse, hosting major players like Medtronic, Boston Scientific, and Johnson & Johnson. Europe, particularly Ireland, Germany, and Switzerland, forms the second pillar, with regions like Ireland's County Galway becoming manufacturing and R&D hubs due to proximity to universities, clinical trial centres, and EU regulators.

China has emerged as the third major player, with companies like Mindray Medical advancing up the value chain from budget and mid-value segments into high-end medical devices. Chinese medical device makers are pursuing aggressive overseas expansion through mergers and acquisitions, establishing sales centres globally, and setting up R&D labs and factories in the US and Europe. Emerging production bases include India, Southeast Asian countries (Singapore, Thailand, Malaysia, Vietnam), and nearshoring locations in the Americas (Mexico, Costa Rica, Dominican Republic, and Puerto Rico), driven by geographic proximity, competitive costs, and favorable trade agreements.

### *Apparel: Asia's Enduring Dominance*

The apparel industry, valued at US$1.8 trillion in 2024 and expected to reach US$2.0 trillion by 2029, employs approximately 430 million workers globally across fashion, clothing, and textile production. China remains the dominant force, leading in three of four key supply chain segments: the world's top exporter of clothing (30.1% global share), textiles (41.5%),

and apparel and textile machinery (35.1%), while ranking fourth in raw textile material exports.

Asia collectively dominates global clothing and textile exports, with China, Bangladesh, Vietnam, Turkey, and India among the top 10 global clothing exporters, accounting for nearly half of world clothing exports. Six Asian countries contribute to two-thirds of global textile exports. Raw textile material suppliers are distributed across the Americas, Oceania, Asia, and Europe, with the US as the unshakable leader, followed by Brazil (which surged to second place in 2024), Australia, China, and India. For apparel and textile machinery, China is the leading supplier, accounting for about one-third of global exports. Other major machinery suppliers are developed countries, with Germany, Japan, Italy, and South Korea completing the top five.

On the consumption side, the US and China are the world's two largest apparel consumers, while the EU and US are the two largest importers.

***Solar: China's Unrivaled Leadership***

Solar power, the third-largest renewable energy source for global electricity generation, experienced remarkable growth with 597 GW of new solar PV capacity installed in 2024, representing an 81% share of newly installed renewable power generation capacity. China's dominance in solar manufacturing is absolute and unparalleled. The country dominated solar PV manufacturing at all stages, controlling approximately 85% of panel production and over 90% of upstream manufacturing stages.

In 2024, China produced 775.8 GW of solar wafers (96.6% of global total) and 695.1 GW of solar cells (92.3% of global production). China also leads in high-tech solar manufacturing equipment and automation, with companies like TCL Zhonghuan implementing Industry 4.0 smart manufacturing systems using AI learning models. Besides China, other countries produce at various stages of the solar supply chain, though at significantly smaller scales. For upstream stages, Germany, the US, and Malaysia maintain limited polysilicon production capacity. Vietnam and Malaysia rank second and third respectively in wafer production. For solar cells, Southeast Asian countries like Malaysia, Vietnam, and Thailand, along with the US, are producers. For downstream panel assembly, Turkey has emerged as the largest producer in the EMEA region, while India, Vietnam, Malaysia, Thailand, and the US have expanded assembly capacity, primarily using imported Chinese cells and components.

***Electric Vehicles: The New Battleground***

Electric vehicle adoption accelerated dramatically between 2023 and 2025, with EV sales reaching about 17 million in 2024, accounting for over 20% of new car sales worldwide. The total EV fleet on the road grew to around 58 million by the end of 2024, more than triple the

stock just three years prior. China, Europe, and the US together made up 95% of 2024 EV sales.

China stands as the undisputed manufacturing powerhouse, producing around 12.9 million EVs in 2024—over 70% of global output—and dominating the battery supply chain. Chinese firm BYD sold more than 4.27 million EVs in 2024, topping global rankings, while CATL supplied about 38% of the world's EV batteries, with BYD ranking second at 17.2%. Tesla, the world's second-largest EV seller, delivered 1.79 million units in 2024, retaining its lead in battery-electric vehicles (BEVs). European manufacturers such as Volkswagen continued to expand EV sales, particularly in Europe, though global growth remains more modest compared with China's rapid scale-up.

Critical minerals for EV batteries are unevenly distributed: Australia and Chile provide over three-quarters of lithium; the Democratic Republic of Congo supplies over 70% of cobalt; and Indonesia has become the dominant producer and processor of nickel for battery use. China plays a central role in refining, processing around 60% of lithium, 70% of cobalt, and up to 90% of rare earth elements, as well as producing most battery-grade graphite.

## Major Drivers Reshaping Global Supply Chains

### *Geopolitics: Decoupling and Fragmentation*

The intensifying China-US rivalry has become the defining geopolitical force reshaping global supply chains across all four industries. The trade war that began in 2018 has escalated into a multidimensional confrontation encompassing technology restrictions, financial sanctions, export controls, and strategic competition over critical resources. Beyond the China-specific actions, the US is pursuing a wider strategy aimed at addressing global trade deficits with nearly all US trading partners. President Trump's 'Liberation Day' tariff policy unveiled in April 2025 imposed a 10% baseline tariff on imported goods from nearly all countries, with higher country-specific tariffs ranging from 11% to 50% on 57 economies with the largest U.S. trade deficits, destabilizing global trade systems.

In the EV sector, geopolitical tensions have manifested through the US *Inflation Reduction Act's* (IRA) local content requirements, European anti-subsidy investigations into Chinese EV imports, and China's retaliatory export controls on critical materials. The European Commission launched an anti-subsidy investigation into Chinese EV imports in September 2023. In December 2023, China imposed export controls on graphite, a material critical for EV battery anodes for which the country accounts for more than 90% of global supply. China had earlier imposed curbs on semiconductor metals gallium and germanium, measures widely interpreted as retaliation for Western technology restrictions. The US's so-called *Uyghur Forced Labor Prevention Act* (UFLPA), effective since June 2022, has been expanded to cover EV components including aluminum and graphite.

For solar, the UFLPA banned imports of goods from Xinjiang, which in 2021 accounted for over half of global polysilicon production. This, combined with duties on Chinese solar wafers and cells, significantly reduced US reliance on solar inputs from China. Trump's second administration further rolled back IRA incentives through the "One Big Beautiful Bill" (OBBB) signed in July 2025, introducing complex Foreign Entity of Concern (FEOC) rules that render solar projects owned or controlled by prohibited foreign entities—including all companies owned or controlled by the Chinese government or its citizens—ineligible for tax credits.

The medical device sector faces similar pressures, with Trump's global tariff policy in 2025 increasing supply chain uncertainties. Tariffs on raw materials for medical devices, such as plastics and steel, drive up sourcing costs, while the ongoing US Commerce Department's Section 232 investigation into semiconductors potentially creates additional costs for chip-intensive devices such as AI-powered diagnostic devices, CT scanners, and imaging devices.

In apparel, escalating great power competition—particularly between China and the US—is driving diversification away from China. The United States Fashion Industry Association's 2025 survey revealed that Trump Administration's escalating tariffs significantly increased sourcing costs for fashion brands and retailers, squeezed profit margins, and led to higher consumer prices. Half of respondents reported declining sales, and over one-fifth had already laid off employees.

***Technology: AI, Automation, and Innovation***

Technological breakthroughs are revolutionizing all four industries, with artificial intelligence emerging as the most transformative force. In medical devices, AI-powered equipment is supporting diagnostic analysis, reducing administrative burdens, and boosting healthcare sector productivity. The global AI-enabled healthcare services market was valued at US$27.1 billion in 2024 and is projected to reach US$347.3 billion by 2032, with a CAGR of 37.6%. North America holds 51.3% of the market share, with 66% of US physicians reporting AI use in healthcare services in 2024, up from 38% in 2023.

AI applications in medical devices span diagnostic analysis (such as machine learning algorithms for sepsis diagnosis and breast cancer risk prediction), medical imaging analysis, robotic technology for minimally invasive surgeries, and remote healthcare services including wearable devices and telemedicine. Companies like Biofourmis have launched AI-driven wearables that reduce 30-day hospital re-admissions by 70% and costs by 38%. Apple announced Project Mulberry, an AI-driven healthcare initiative expected to launch in 2026, integrating data from various devices to provide customized healthcare recommendations.

In apparel, the potential for widespread AI application became evident in 2025, driven by advancements in generative AI. Leading companies are integrating AI across the supply

chain—from product design and lookbook creation to order planning, warehousing, logistics, and all the way to on-site applications such as fabric inspection, colour formulation systems, and hybridization for cultivating raw textile materials. Manufacturing automation is accelerating, with both developed and developing countries recognizing the importance of automating textile and apparel manufacturing to maintain competitiveness. Chinese textile machinery advancements, combined with global investments by Chinese apparel firms, further facilitate automation adoption worldwide.

For solar, Chinese manufacturers lead in integrating AI into manufacturing processes. TCL Zhonghuan implemented an Industry 4.0 smart manufacturing system using AI learning models to enhance the flexibility and efficiency of its manufacturing process, achieving a 23% reduction in energy intensity. AI-driven systems enable real-time quality control, enhance precision in processes like wafer slicing and cell assembly, and hold significant potential for R&D, potentially accelerating the discovery of stable and easy-to-manufacture perovskite structures for cheaper, more efficient solar cells.

In the EV sector, technology developments focus on battery chemistry, critical material substitution, and advanced manufacturing processes. Battery chemistry diversification has accelerated, with lithium iron phosphate (LFP) batteries gaining popularity for their low cost, enhanced safety, and improving energy density. Globally, LFP accounted for nearly half of the EV-battery market in 2024, with about three-quarters of new EVs in China now using LFP cells. The race for next-generation technologies like solid-state batteries and AI-driven manufacturing processes is intensifying competition among global manufacturers. In electric motors, automakers are pursuing rare-earth-free designs to reduce reliance on Chinese-dominated supply chains. China currently controls approximately 70% of rare earth element mining, 74% of processing, and produces nearly all high-performance neodymium-iron-boron (NdFeB) permanent magnets used in over 86% of EV traction motors worldwide in 2024. In 2023, Tesla announced that its next-generation drive units will eliminate rare earths entirely, mainly through innovative induction motor designs. European automakers including BMW and Renault are adopting externally excited synchronous motors (EESMs), which use copper windings instead of permanent magnets to achieve magnet-free operation. While induction motors and EESMs tend to be slightly less efficient, heavier, and require more intensive cooling than permanent-magnet motors, they offer supply chain independence—a strategic priority as geopolitical tensions intensify.

***ESG and Sustainability: From Aspiration to Regulation***

Environmental, social, and governance (ESG) considerations have evolved from voluntary commitments to regulatory mandates, fundamentally reshaping supply chain strategies across all industries. The EU continues to lead in formalizing, regulating, and operationalizing ESG through comprehensive legislation.

The EU's Digital Product Passport (DPP), effective from 2024 and becoming mandatory for nearly all physical products by 2030, provides comprehensive, verifiable data on a product's environmental impact, materials composition, durability, repairability, and end-of-life recyclability. For apparel, this represents a pragmatic step toward operationalizing ESG, strengthening legal compliance and simplifying processes across the entire value chain. The EU Batteries Regulation, enacted in 2023 and phased in gradually from 2024, mandates carbon footprint disclosure and minimum recycled content for EV batteries.

The *Carbon Border Adjustment Mechanism* (CBAM), which entered a transitional reporting phase in 2023-2025 and will apply carbon costs to imports from 2026, initially covers cement, iron and steel, aluminum, fertilizers, electricity, and hydrogen, but experts anticipate textiles, apparel, and potentially solar products could face CBAM levies after its scope expands post-2026. CBAM aims to capture more than 50% of emissions in sectors covered by the EU Emissions Trading System.

China, as a dominant player across all four industries, is assuming greater ESG responsibilities. The Chinese apparel sector is moving aggressively toward the country's "dual carbon" goals—peaking carbon dioxide emissions by 2030 and achieving carbon neutrality by 2060—by substantially reducing domestic carbon footprints while forging partnerships with key apparel manufacturing countries in Asia and Africa to promote sustainability, fair labour practices, and gender equality. The China National Textile and Apparel Council (CNTAC) formed the Sustainable Textiles of the Asian Region (STAR) Network in 2017 with nine organizations from six Asian countries, creating the first regional alliance for sharing sustainability standards and advancing gender equality.

In the US, state-level initiatives continue despite federal setbacks. California enacted the Responsible Textile Recovery Act in 2024 (effective 2025) for textile extended producer responsibility, and introduced the Fashion Environmental Accountability Act in 2025 for emissions reporting. New York's Fashion Sustainability and Social Accountability Act, a pending bill reintroduced in February 2025, would require apparel companies with more than US$100 million in annual global revenue operating in New York to remap entire supply chains to ensure environmental and human rights standards compliance.

In the medical device sector, ESG practices encompass carbon emissions reduction, waste management, healthcare accessibility, workforce diversity, product safety, and regulatory

governance. Leading manufacturers like Medtronic committed to net-zero emissions across Scope 1, 2, and 3 by 2045, achieving a 52% reduction in GHG emissions intensity by 2024 compared to 2020, surpassing its 2025 target. The company also reduced waste by 19% through repurposing and recycling materials.

For solar, ESG considerations include the carbon footprint of solar panel production itself, labour rights concerns (particularly regarding US-alleged forced labour in Xinjiang), and the broader commitment to renewable energy deployment. Chinese solar producers have begun addressing these issues, with JinkoSolar operating a 12MW pilot PV recycling line which has achieved an overall recycling rate of 92% for solar panels and 95% recovery rate for embedded metals.

In the EV sector, battery supply chain due diligence has emerged as a critical ESG priority alongside carbon and recycling mandates. The industry faces scrutiny over sourcing practices for critical minerals—cobalt from the Democratic Republic of Congo raises concerns over artisanal mining and labour conditions, while nickel from Indonesia's high-pressure acid leach (HPAL) facilities presents environmental challenges including acidic tailings management in seismically active regions. Automakers are responding by pursuing traceable and responsible supply chains through long-term procurement agreements—Tesla has secured nickel from Canadian miners meeting ESG standards and a spodumene supply deal with Piedmont Lithium, while battery and cathode producers have formed integrated mining-to-processing ventures in Indonesia with firms like Huayou Cobalt and Tsingshan Group.

***Industrial Policies: Subsidies, Incentives, and Local Content Requirements***

Government industrial policies have become decisive factors in shaping supply chain geography, with countries implementing comprehensive support mechanisms to develop domestic manufacturing capabilities.

For solar, China's industrial policies fundamentally transformed the global landscape. Throughout the 2000s, an estimated US$50 billion from private and public sources was invested in solar manufacturing in China, enabling economies of scale and contributing to significant production cost declines. Following the 2008 financial crisis, China introduced a nationwide feed-in tariff scheme for solar PV in 2011 to stimulate domestic demand. More recently, to curb excessive investment and stabilize prices, China reduced export tax rebates from 13% to 9%, mandated a minimum 30% capital ratio for new projects, and enhanced power conversion efficiency standards for solar cells and panels.

The US *Infrastructure Investment and Jobs Act* (IIJA) and *Inflation Reduction Act* (IRA), enacted during the Biden administration, provided historic grants, subsidies, and tax credits for renewable energy. The IRA included an estimated US$1 trillion or more in tax incentives

over 10 years, with the Advanced Manufacturing Production Tax Credit (45X credit) covering solar raw materials, cells, panels, and supporting products. From the third quarter of 2021 to the second quarter of 2023, a staggering US$227 billion in public and private investments was announced for utility-scale solar projects. However, Trump's OBBB signed in July 2025 significantly rolled back these incentives, threatening over 330 solar and solar-powered storage factories in the US.

India's *Production Linked Incentive* (PLI) Scheme, introduced in March 2020 and expanded in November 2020 for high-efficiency solar panels, allocated more than US$3 billion to build 130.7 GW of solar manufacturing capacity. As of June 2025, manufacturing capacity of 18.5 GW of solar modules, 9.7 GW of solar cells, and 2.2 GW of ingot-wafer production had been developed under the PLI Scheme. The Approved List of Models and Manufacturers (ALMM) mandate, reinstated from April 2024, creates a non-tariff barrier for imported products, giving domestic solar producers significant advantages over foreign competitors.

For EVs, the US IRA's manufacturing tax credits began influencing investment decisions from early 2023. However, following the 2025 change of administration, the legislation came under review, creating uncertainty for automakers. China's *New Energy Vehicle Industry Development Plan (2021-2035)* and extension of purchase tax exemptions through 2027 sustain domestic demand for EVs. Europe's stringent EU Batteries Regulation and CBAM mandate sustainability disclosures and will apply carbon costs to imports. These measures raise the compliance bar substantially, effectively favouring low-carbon producers while disadvantaging manufacturers relying on coal-intensive production. Indonesia's nickel export ban exemplifies how countries with critical mineral endowments can use industrial policy to drive economic development. By prohibiting unprocessed nickel ore exports, Indonesia attracted substantial foreign investment, particularly from Chinese companies, to establish nickel refining and processing facilities. This strategy successfully transformed Indonesia into a dominant nickel processing hub for EV batteries, demonstrating how mineral-rich countries can leverage export restrictions to move up the value chain and capture greater economic benefits from their natural resources.

In medical devices, India announced plans for establishing medical device parks, with traditional Indian conglomerates from sectors such as automotive, electronics, and textiles increasingly diversifying into medical device manufacturing to fulfil growing healthcare demand. Southeast Asian countries such as Malaysia, Indonesia, Thailand and Singapore have provided strong government incentives and regulatory support to promote medical tourism and attract investment from global device manufacturers. For example, Malaysia's New Industrial Master Plan 2030 designates medical devices as a priority sector, aiming to advance the position of the medical device industry in the global value chain. The Malaysian government provides incentives to attract foreign investment, including tax exemptions such

as Pioneer Status and Investment Tax Allowances, with additional incentives available at specialized industrial zones like Kulim Hi-Tech Park. Reputable multinational companies like Abbott and B-Braun have established manufacturing bases in Malaysia, manufacturing high-value products such as cardiac rhythm management devices and implantable cardioverter defibrillators. Indonesia's Omnibus Health Law allows for 100% foreign ownership in hospitals (subject to minimum bed requirements) and certain medical device manufacturing and distribution activities, drawing interest from multinationals including Siemens Healthineers, Philips, and GE Healthcare, who maintain a commercial presence in the country.

***Trade Agreements and Strategic Partnerships: Driving Supply Chain Integration***

Trade agreements and strategic partnerships play a pivotal role in shaping regional and global supply chain architecture. By reducing or eliminating tariffs, harmonizing standards, and streamlining customs procedures, these frameworks enable businesses to optimize sourcing and production beyond national borders, enhancing both efficiency and resilience.

The Regional Comprehensive Economic Partnership (RCEP), effective since January 2022, demonstrates the breadth of modern agreements. Bringing together China, ASEAN, Japan, South Korea, Australia, and New Zealand, RCEP will eliminate tariffs on at least 92% of goods traded among RCEP members over the next 20 years. Beyond market access, RCEP incorporates rules of origin cumulation, trade facilitation, and provisions for services, investment, e-commerce, and intellectual property, making it much easier for companies to operate integrated value chains across Asia-Pacific. For example, Chinese textile firms can supply ASEAN garment manufacturers under one harmonized regulatory framework, while solar producers leverage duty-free movement of components through Southeast Asia for final assembly and export.

In North America, the *United States-Mexico-Canada Agreement* (USMCA) incentivizes nearshoring by enabling seamless movement of goods and components., Chinese auto parts manufacturers, for instance, have established production facilities in Mexico to meet USMCA's 75% regional content requirements and maintain access to North American automakers' supply chains, while medical device and apparel supply chains benefit from short lead times and robust regional rules.

The EU not only operates as an internal free trade area but also forms a web of external agreements and partnerships. Turkey, for example, benefits from its customs union with the EU, being Europe-5's third-largest apparel sourcing country and the region’s leading nearshore location, while also hosting major solar panel assembly using imported Chinese cells. The *EU-SADC Economic Partnership Agreement* provides Namibia with duty-free access, while the EU’s *Enhanced Partnership and Cooperation Agreement* with Kazakhstan establishes regulatory cooperation, though without preferential tariff rates. Further, recent

EU memoranda of understanding with Namibia and Kazakhstan on critical minerals reflect a new breed of strategic partnerships aimed at securing supply chain resilience in strategic sectors like batteries and renewables.

In short, companies tailor global supply chains to maximize the benefits of these trade frameworks—locating operations where agreements provide the greatest advantages and using preferential access, harmonized rules, and strategic sector MoUs as tools for cost, compliance, and risk optimization. This evolving network of agreements is fundamental to current and future supply chain strategy across industries.

***Risk Management and Resilience: From 'Just-in-Time' to 'Just-in-Case'***

The COVID-19 pandemic marked a watershed moment, exposing vulnerabilities in globally dispersed, efficiency-optimized supply chains. The medical device market troughed during the pandemic due to barriers to medical access, postponed treatments, stringent regulatory processes, and inflated operation costs. Many countries suffered shortages of medical supplies and equipment due to lockdowns, prompting policymakers, manufacturers, and healthcare institutions to enhance supply chain resilience by re-evaluating and diversifying production locations.

In July 2025, the European Commission announced preparations for medical emergencies by launching the EU Stockpiling and Medical Countermeasures Strategies, and doubling investment in the Health Emergency Preparedness and Response Authority (HERA) up to EUR 200 million. Medical device manufacturers adopted various supply chain strategies including pursuing multiple sourcing, optimizing safety stock, applying product modularity and interchangeability, forming strategic partnerships, increasing supply chain visibility, and embracing market proximity.

Large medical device manufacturers adopted diversification and localization strategies to enhance supply chain resilience and mitigate uncertainties from potential tariff threats. Some have set up "twin factory systems," allowing products made in China for the Chinese market and products made in the US/Europe for western markets. Others have extended manufacturing networks from the US, Europe, and China to countries such as Malaysia, Vietnam, and Thailand in Asia; and Mexico, Costa Rica, the Dominican Republic, and Puerto Rico in the Americas.

For apparel, recurring shocks such as regional conflicts and pandemics prompted a shift towards "just in case" supply chain strategies. The United States Fashion Industry Association's 2025 survey revealed that due to increased tariffs, many firms delayed or cancelled orders, or asked vendors to share tariff burden, creating ripple effects across supply chains. Many suppliers halted new investments given huge uncertainty, while some struggled to stay in business.

In the EV sector, automakers and battery producers have shifted toward localization of production to meet policy requirements, 'friend-shoring' to politically aligned countries (illustrated by EU partnerships with Namibia and Australia for critical minerals), and vertical integration with firms like Tesla, BYD, and Volkswagen investing directly in mining, refining, and battery manufacturing. These strategies aim to reduce exposure to geopolitical shocks, diversify supply, and strengthen resilience, even if they sometimes raise costs or duplicate capacity.

## Development Trends: Diversification, Nearshoring, and Reshoring

***Diversification: Gradual but Inexorable***

The dominant trend across all four industries is diversification away from concentrated production bases, particularly China, though the pace and extent vary significantly by sector.

In apparel, China's export share has decreased only in the final segment—apparel manufacturing—dropping from a peak of 40% in 2013 to 30% currently. Meanwhile, its export shares in textiles, raw materials, and machinery have increased. Poland, Mexico, and Pakistan recorded the highest increases in export share from 2018 to 2023 in apparel manufacturing, but none surpassed 2.5% of the global total as of 2023. Bangladesh and Vietnam, top apparel exporters in Asia, saw export shares increase over the ten-year period from 2013 to 2023, yet both experienced a decline from 2018 to 2023, indicating a recent slowdown in the shift of apparel production to Asian countries. This evidence suggests that while diversification is underway, the process will be gradual and prolonged.

For medical devices, diversification strategies vary by company size and product type. Large manufacturers like GE Healthcare and Philips explore diversification by seeking more sourcing bases in Europe, while Medtronic and Baxter International pursue nearshoring in Latin America, and Stryker and Zimmer Biomet explore onshoring within the US. However, for small companies, relocation is often not feasible due to the roughly 24-month construction timeline and significant investment required. Additionally, some location shifts may require new FDA approval rounds, prolonging production resumption.

In the EV sector, diversification manifests through battery chemistry (e.g., shift from nickel-rich to LFP batteries), geographic expansion of manufacturing (Europe's battery belt across Eastern and Northern Europe), and critical mineral sourcing partnerships. Despite efforts to diversify EV battery production, China maintained approximately 80% of global cell manufacturing capacity in 2024, while controlling around 90% of cathode and anode materials capacity. Battery pack costs remain a major barrier to further diversification, with Chinese LFP packs averaging US$53/kWh in late 2024 compared to the global average of US$111/kWh, creating substantial cost pressures for non-Chinese producers attempting to compete.

For solar, despite substantial investments in manufacturing capacity outside China, the International Energy Agency estimates China will maintain at least 75% of global manufacturing capacity across all segments by 2030, including 90% for polysilicon, 95% for wafers, 85% for cells, and 75% for panels. The recent plunge in solar product prices—60% decline for solar modules from late 2022 to end of 2024—may defer new investments in solar manufacturing outside China, further reinforcing China's position.

***Nearshoring and Reshoring: Promise Versus Reality***

Nearshoring—relocating operations from distant countries back to regions closer to customers—has gained significant attention across all industries, but actual progress varies considerably.

For the US apparel market, nearshoring points to Mexico (as a USMCA member) and Central American countries under CAFTA-DR. In 2023, Mexico for the first time in 20 years surpassed China to become the biggest goods exporter to the US. However, analysis reveals Mexico's share of US imports in the apparel sector increased noticeably only in textile machinery, reaching the top position in 2024. CAFTA-DR countries' share in US apparel imports remained flat as of 2024.

Prominent American brands like Columbia pledged to purchase up to US$200 million in products from the Northern Triangle (Guatemala, Honduras, El Salvador), Target committed to increase sourcing in the region by US$300 million, and Gap pledged a US$150 million increase by 2025. Asian companies supplying US brands are establishing joint ventures in Mexico—Pakistani firm Artistic Milliners and Vietnamese firm Phong Phu International are transferring orders for GAP and Target to Mexico. South Korea-based Hansae Co., Ltd. is building localized fabric sourcing in Central America through partnerships with Willbes Dominica Synthetic Mill (Dominican Republic) and Northern Textiles (Honduras), a GK Global subsidiary, to maximize nearshoring advantages for its Haitian operations. However, Trump's erratic use of tariffs as a weapon, irrespective of ally or foe, has prompted many investors to adopt a wait-and-see approach, slowing facility construction in nearshoring destinations.

For Europe's core apparel market, nearshoring bases refer to Eastern Europe, North Africa (Morocco, Tunisia), and Western Asia (Turkey). Turkey is Europe's third-largest sourcing country and top nearshoring location, but its share remained steady at around 8% over the past decade, with slight declines in 2023-2024. Turkey's share in Europe's textile and clothing imports has stagnated due to its unstable domestic economy. Poland, Austria, Czechia, and Morocco also rank among Europe's top nearshoring suppliers, but their market shares remain too small to gain significance.

In medical devices, nearshoring production bases in the Americas play an important role in the US market, driven by geographic proximity, competitive costs, and favourable trade

agreements. Costa Rica was the third-largest supplier of medical instruments to the US with an import value of US$4.2 billion in 2024, and the Dominican Republic ranked seventh at US$1.7 billion. Many international medical device manufacturers established businesses in these countries, which offer sufficient skilled labour and regional proximity enabling quicker response times, reduced inventory costs, and just-in-time manufacturing.

Mexico's role as a nearshoring base for US medical devices has grown steadily under the USMCA, effective since July 2020. Among the top ten exporters of Mexico's medical equipment sector, the majority originated from the US. However, Trump's announcement in February 2025 to impose a 25% additional tariff on imports from Mexico, followed by a series of negotiations and extensions, created ongoing trade uncertainties, prompting manufacturers to review their location strategies.

For solar, reshoring and onshoring efforts in the US face significant challenges. While solar panel assembly capacity has expanded dramatically in the US—reaching 55.4 GW per year by June 2025—most involves only assembly of solar panels from cells and components produced elsewhere, often by overseas subsidiaries of Chinese solar companies. Building a complete solar supply chain within the US faces obstacles including huge investment costs, lengthy construction timelines, technical complexities, and intense price competition, especially following the OBBB's passage in July 2025. Leading Chinese solar manufacturers had established solar panel manufacturing capacity in the US prior to Trump's second term to circumvent import duties and take advantage of IRA incentives, with companies like LONGi, JinkoSolar, Trina Solar, and JA Solar announcing facilities with combined capacity exceeding 20 GW. However, following the OBBB's passage, Chinese companies scaled back expansion, with JA Solar selling its Arizona module assembly plant to Corning in April 2025.

For EVs, nearshoring and reshoring efforts show more substantial progress but face mounting challenges. In North America, the US has become the regional hub of EV assembly expansion driven by IRA incentives. Tesla's Fremont (California) and Austin (Texas) plants anchor the west and south, while Ford's Rouge Electric Vehicle Centre in Michigan and Volkswagen's Chattanooga (Tennessee) facility serve the Midwest and southeast. Hyundai's Metaplant America in Georgia began production in late 2024 with a targeted annual capacity of 300,000 units. Nevertheless, the subsequent review of the IRA legislation has created uncertainty for automakers, prompting some firms to accelerate projects to qualify under existing rules, while others scaled back or delayed EV production plans.

Mexico serves as a key nearshoring destination for the North American EV market. General Motors' Ramos Arizpe plant in Mexico produces the Blazer EV and Equinox EV for continental markets. Under the USMCA, vehicles must meet a 75% regional-value-content requirement for tariff-free access. The IRA further ties federal tax credits to North-American final assembly and to the sourcing or processing of critical minerals in the US or its free-

trade-agreement partners. However, Tesla's planned Nuevo León Gigafactory, announced in 2023, remains delayed amid macroeconomic uncertainty, and Trump's announcement in February 2025 to impose a 25% additional tariff on imports from Mexico created ongoing uncertainties. Meanwhile, Canada is positioning itself as a regional refining and processing hub for critical minerals supporting EV battery production. Electra Battery Materials' cobalt refinery in Ontario is under development, and FPX Nickel is planning the Baptiste Project in British Columbia.

In Europe, EV manufacturing is centred in Germany, France and Central-Eastern Europe. Volkswagen's Zwickau complex was fully converted to all-electric output by 2022, while Renault's Douai plant in northern France integrates battery-pack assembly on site. Central-Eastern Europe is growing in importance as a lower-cost nearshoring corridor—Volvo's Košice plant in Slovakia, Mercedes-Benz Kecskemét in Hungary, and Škoda Mladá Boleslav in Czechia are adding significant EV capacity, while BYD's factory in Szeged, Hungary, is scheduled to begin mass production in 2026. Despite these investments, Europe's battery build-out faces mounting headwinds, with flagship projects suffering delays, insolvency, or restructuring. European battery manufacturers struggle with production scaling challenges, limited experience in high-volume manufacturing, and intense price competition from Asian competitors who benefit from decades of supply chain integration and economies of scale.

The overarching pattern across all industries shows that while nearshoring and reshoring ambitions are substantial, execution faces persistent challenges including the need for substantial capital investment, dependence on Chinese upstream materials and components, underdeveloped infrastructure, policy uncertainty, and intense cost competition from established production bases.

## Chinese Enterprises Going Global: Redefining Global Supply Chain Geographies

The phenomenon of Chinese enterprises ‘going global’ has fundamentally transformed from opportunistic expansion to strategic necessity across the medical device, apparel, solar, and electric vehicle industries. This outward movement represents not merely geographic diversification but a comprehensive internationalization encompassing manufacturing, technology transfer, brand building, and ecosystem leadership, reshaping China's role from the world's factory to a multifaceted global industrial power.

### *Medical Devices: Diversified Market Penetration Strategies*

Chinese medical device companies are pursuing aggressive overseas expansion through mergers and acquisitions, strategic alliances, setting up sales centres, and establishing manufacturing and R&D facilities in target markets. Among the top 20 Chinese medical device companies, the predominant approach involves establishing regional branches and

sales centres in target markets including the US, Europe, and Southeast Asia. Over half have established operations in Hong Kong, which serves as a strategic bridge connecting the Chinese mainland to international markets.

Mindray Medical, China's largest medical device company, exemplifies the M&A-driven globalization model. The company set up its first US office in 2008 by acquiring Datascope's patient monitoring business, and acquired US-based imaging device company Zonare in 2013. By 2024, overseas business accounted for 45% of Mindray's overall revenue, with the company becoming one of the top three suppliers of anesthesia devices, monitors, and ultrasound machines in North America, serving over 10,000 US medical institutions.

United Imaging Healthcare (UIH) has established a global network spanning more than 85 countries, working closely with local hospitals and medical institutions in North America and Europe. UIH also collaborates with top hospitals and universities in Belt and Road countries including Astana Medical University in Kazakhstan, Hussein King Cancer Centre in Jordan, and Morocco's Health Garden. In response to US tariff policies, UIH has announced plans to establish new manufacturing bases in Southeast Asia and Latin America between 2025 and 2027.

In terms of overseas investment, a rising number of long-term contracts between Chinese suppliers and foreign hospitals and medical organizations have been signed. The number of outbound investment deals made by Chinese healthcare suppliers surged from 5 in 2023 to 15 in 2024. Of these, over 40% were sealed with companies in the US, followed by Germany, the UK, Spain, South Korea, and Australia.

Manufacturing globalization remains selective and strategic. High-end device manufacturers such as Mindray Medical, Yuwell Medical, Blue Sail Medical, Tofflon Science and Technology, Sinocare Inc, and MGI Technology operate overseas manufacturing facilities in the US, Germany, and other European countries to benefit from market proximity, mature medical infrastructure, and alignment with local regulatory requirements. On the other hand, companies making low- and mid-end devices, such as medical gloves, consumables, and rehabilitation equipment, have extended their production lines beyond the Chinese mainland into emerging countries to reduce cost, such as Lepu Medical in Malaysia, Intco Medical in Vietnam, and Zhende Medical in Ethiopia, Kenya, and Mexico.

***Apparel: From Manufacturing Migration to Brand Internationalization***

Chinese apparel firms have pursued global expansion through three distinct waves, evolving from low-cost manufacturing suppliers to emerging international brand players. From the 1980s through 2007, China became the world's apparel factory through original equipment manufacturing (OEM) for major global brands like Nike, Adidas, and Gap, while overseas investment remained limited primarily to state-owned enterprises providing foreign aid or

circumventing quotas and trade restrictions under the Multifibre Arrangement. During this era, Hong Kong served as a crucial intermediary hub, and skilled Chinese textile workers from cities like Wenzhou migrated to places like Prato, Italy, bringing fast fashion production efficiency to European luxury manufacturing.

The second wave (2008-2017) followed the global financial crisis and rising domestic costs in China, prompting international brands to diversify sourcing to lower-cost countries in Southeast and South Asia. Chinese apparel firms followed these orders, with outbound investment reaching US$6.2 billion between 2015-2018—six times that of 2005–2010—concentrated heavily in Vietnam, Cambodia, and Bangladesh. These firms not only established assembly operations but also invested across the entire textile value chain, developing industrial parks to attract other Chinese manufacturers, creating complete supply chain ecosystems in host countries.

The third wave (2018-present) represents a fundamental transformation beyond manufacturing relocation. While the China-US trade war accelerated factory relocations to countries with preferential market access like Bangladesh, Egypt, and Ethiopia, this period more significantly marks the rise of Chinese brands as global fashion players. Established firms like Bosideng and ANTA Sports have built international recognition through quality upgrades, fashion week participation, strategic acquisitions (such as ANTA's purchase of Amer Sports and Jack Wolfskin), and selective market entry, while internet-era brands like Cupshe, Cider, BloomChic, and Urban Revivo leverage e-commerce platforms, social media marketing, and design innovation to capture niche markets worldwide.

***Solar: From Southeast Asia to Global Integration***

Chinese solar manufacturers have established a globally distributed production network in response to escalating trade remedies. Since mid-2010s, major players including JinkoSolar, Trina Solar, LONGi, and JA Solar have relocated US-oriented production to Southeast Asia, where Chinese companies now control over 50% of panel production capacity and nearly two-thirds of cell manufacturing capacity. As of March 2024, Chinese-owned solar manufacturing capacity in the region included 27.6 GW of silicon wafers, 45.2 GW of solar cells, and 50.2 GW of solar panels.

The geographic footprint is rapidly diversifying beyond Southeast Asia. The Middle East and North Africa (MENA) region has emerged as a strategic investment destination, with JinkoSolar announcing plans in July 2024 to establish a 10 GW joint venture manufacturing facility in Saudi Arabia—the largest overseas cell and panel factory established by a Chinese company. Other Chinese solar companies are setting up production facilities in the UAE, Oman, and Egypt, positioning Chinese firms to control the majority of solar manufacturing capacity in MENA within the next five to ten years.

Other markets, such as Latin America, Bangladesh, and Pakistan have also emerged as potential destinations for Chinese solar investments. For instance, SJEF Solar is building a solar cell factory in Puebla of Mexico, expected to commence operations by the end of 2025.

In addition, leading Chinese solar manufacturers had established solar panel manufacturing capacity in the US prior to Trump's second term to circumvent import duties and capitalize on IRA incentives. Companies like LONGi, JinkoSolar, and Trina Solar announced facilities with combined capacity exceeding 20 GW. However, following the OBBB's passage in July 2025, Chinese companies scaled back expansion, with JA Solar selling its Arizona plant to Corning in April 2025. This pivot from the US to the Middle East, North Africa, and other regions demonstrates Chinese companies' agility in responding to shifting policy environments while maintaining global manufacturing leadership.

A transformative trend is the relocation of entire vertically integrated supply chains rather than just downstream assembly. Sunrev Solar began construction on a US$200 million vertically integrated manufacturing facility in Egypt in June 2025, encompassing 2 GW of cell and module production initially, with plans to expand to localized production of silicon ingots and wafers. Similarly, Trina Solar plans an integrated manufacturing facility in the UAE with annual capacity of 50,000 tons of high-purity polysilicon, 30 GW of wafers, and 5 GW of cells and panels. By localizing complete supply chains in countries with lower geopolitical risks, Chinese companies can mitigate the risks associated with anti-dumping and countervailing duty measures and maintain access to major markets, particularly the US. Furthermore, this approach promotes technology transfer to host countries, contributing to their industrialization. This enables Chinese companies to establish themselves as trusted partners in local markets, thereby gaining support from both local consumers and governments.

***Electric Vehicles: Capital-Intensive Global Expansion***

Chinese electric vehicle enterprises have embarked on a dramatic global expansion, transforming from an export-led model to establishing deeply integrated overseas production footprints. In 2023, China overtook Japan to become the world's largest vehicle exporter, shipping nearly one million EVs primarily to Europe, Southeast Asia, and Latin America. Major automakers including BYD, SAIC-MG, Geely, and NIO have established or announced assembly facilities across Thailand, Hungary, Brazil, and Mexico to secure local market access and qualify for regional incentives.

Chinese EV and battery manufacturers have deployed capital on an extraordinary scale, with cumulative outbound investment reaching US$143 billion between 2014 and Q2 2025, representing the most capital-intensive globalization wave in the EV supply chain. The year 2024 marked a watershed moment: Chinese companies invested US$16 billion in overseas

supply chain capacity, surpassing the US$15 billion committed domestically for the first time in the industry's history. Battery manufacturing now dominates outbound investment, accounting for 74% of overseas investment in 2024, underscoring the capital-intensive nature of cell production and the early-mover advantage of firms such as CATL.

Geographically, Chinese EV investments have shifted from a Europe-centric model to Asia-first diversification. Europe attracted US$18 billion in investment between 2014 and Q2 2025 and hosts CATL's US$7.3 billion gigafactory in Debrecen—the second-largest battery production site outside China. BYD's factory in Szeged, Hungary, is scheduled to begin mass production in 2026. However, Asia now draws 33% of new investment since 2024, with Indonesia leading at US$22 billion, leveraging its nickel resources and massive domestic market targeting 2.5 million EVs by 2030. Huayou Cobalt and Tsingshan Group are developing integrated refining projects in Morowali and Weda Bay. BYD is building a US$1 billion plant in West Java, which is slated to become operational in January 2026. Thailand has positioned itself as a regional export hub, with BYD's 150,000-unit plant shipping vehicles across ASEAN and to Europe.

The Middle East and North Africa (MENA) captured 25% of new investment since 2024, with Turkey emerging as a strategic bridge to European markets. Africa has gained prominence in upstream minerals, receiving 75% of Chinese raw materials investment in Q2 2024 as firms diversify beyond traditional Asian and Latin American sources. Chinese investors including Huayou Cobalt (operating Zimbabwe's Arcadia lithium mine), Sinomine (Bikita Minerals), Chengxin, and Canmax have expanded their stakes across mining and processing to build local refining capacity in Zimbabwe. This demonstrate Chinese enterprises' strategic initiative to secure the entire supply chain, from raw materials to finished vehicles.

***Strategic Implications: From Geographic Diversification to Ecosystem Leadership***

Chinese enterprises' global expansion across these four industries shares common drivers: circumventing trade barriers, securing market access, meeting local-content requirements, and building resilient supply chains. Yet sector-specific patterns emerge. Solar and EV investments are capital-intensive and increasingly focused on vertically integrated supply chains in resource-rich or strategically located countries. Apparel globalization balances cost-driven manufacturing relocation with brand-building in premium markets. Medical devices prioritize sales network expansion while selectively localizing high-value manufacturing.

The geographic centre of gravity is shifting. While Europe and North America remain important for market access and high-end manufacturing, Asia—particularly Southeast Asia, Indonesia, and Thailand—has become the primary destination for integrated manufacturing investment. The MENA region is emerging as a strategic nexus, offering large domestic markets, government support, and bridge access to Europe and Africa. African countries are

gaining prominence in upstream mineral extraction and, increasingly, in apparel manufacturing with duty-free access to major markets.

This globalization wave is accelerating rather than diminishing China's influence in global supply chains. By embedding production capabilities abroad while retaining control over technology, brands, and upstream materials, Chinese enterprises are constructing globally distributed yet China-coordinated supply networks. Trade barriers intended to reduce dependence on China are, paradoxically, catalyzing the internationalization of Chinese manufacturing capital and extending the reach of Chinese firms deeper into regional production ecosystems. As these investments mature, the result will not be decoupling but a more complex interdependence—one in which Chinese enterprises operate as truly multinational players with localized production serving regional markets while retaining strategic coordination and technological leadership from their home base.

## Future Forecasts and Scenario Planning through 2030 and beyond

The global supply chain landscape for medical devices, apparel, solar, and electric vehicles is evolving along multiple simultaneous pathways rather than sequential stages. Three plausible scenarios are emerging concurrently, each driven by different dominant forces—geopolitics, economics, and sustainability—and each carrying distinct implications for cost structures, innovation trajectories, and resilience capabilities. Companies and countries will likely experience elements of all three scenarios simultaneously, with the balance determined by industry characteristics, firm strategies, and policy choices.

## Scenario 1: Fragmented Blocs—Regional Supply Spheres

Rather than collapsing into hostile, non-trading camps, the global economy reorganizes around three giant trade groupings, each functioning as integrated regional networks with distinct protocols and internal supply chain ecosystems: Asia (anchored by China and India, encompassing ASEAN and extending through RCEP/CPTPP frameworks), EMEA (Europe, the Middle East, and Africa, with the EU as the regulatory and technological core), and the Americas (led by the US through USMCA and expanding Western Hemisphere partnerships). Each grouping builds deeply integrated supply chains and trades intensely internally, while maintaining selective external trade with the other two groupings, creating a layered rather than binary structure.

***Solar PV***

The Asian bloc consolidates dominance through vertical integration. China is likely to maintain 90% of polysilicon refining, 95% of wafer production, and 85% of cell manufacturing, supplying not only domestic demand but also ASEAN, South Asia, and Belt and Road partners in Africa and the Middle East. RCEP's tariff elimination on solar inputs will

accelerate intra-Asian supply chain integration—as Chinese manufacturers increasingly focus on high-value polysilicon and cell production, Thailand, Vietnam, and Malaysia can assemble modules from Chinese intermediate products for export across Southeast Asia, while India's PLI-supported capacity serves South Asian markets. Major Chinese producers continue to establish integrated facilities in Saudi Arabia (such as JinkoSolar's 10 GW joint venture), Egypt (such as Sunrev's polysilicon-to-panel complex), and Indonesia, positioning Asia to control 80% of global solar manufacturing by 2030.

The EMEA bloc pursues strategic autonomy through industrial policy. The EU leverages CBAM carbon tariffs and domestic content requirements to build regional capacity, anchored by Turkey (Europe's largest panel producer), supplemented by North African assembly (Morocco, Egypt) using European technology and Middle Eastern capital. However, cost competitiveness lags—EMEA panels cost 50% more than Asian equivalents due to smaller scale and higher energy costs, limiting deployment speed and climate progress.

The Americas bloc prioritizes nearshoring and security of supply. Despite OBBB setbacks, the US might still sustain 50–60 GW of domestic solar panel manufacturing capacity through continued state-level incentives (e.g., in California and Texas) and defense procurement mandates. Mexico will emerge as a hemispheric hub thanks to its proximity to the US, hosting final assembly plants of Chinese firms looking to access the US market, while sourcing cells from Asian facilities. Brazil will become a critical raw material supplier, with polysilicon investments serving downstream manufacturers within the region.

Cross-bloc trade faces mounting barriers. The US has imposed Section 201 tariffs (14% from February 2025), Section 301 tariffs (50% on Chinese cells and modules since September 2024, extended to wafers and polysilicon since January 2025), and AD/CVD on products from Cambodia, Malaysia, Thailand, and Vietnam. The EU has launched anti-subsidy investigations and imposed AD/CVD on solar glass from the Chinese mainland, Taiwan, China, and Malaysia. These barriers will substantially reduce cross-bloc trade volumes.

***Electric Vehicles***

Regional battery ecosystems form around existing capacity concentrations and mineral access. In 2024, China produced approximately 12.9 million EVs—over 70% of global output. CATL supplied about 38% of the world's EV batteries, with BYD ranking second at 17.2%. The Asian bloc under RCEP frameworks will integrate Chinese battery production with Indonesian nickel refining, Australian lithium mining, and regional assembly across China, Thailand, Vietnam, and Indonesia.

The EMEA bloc constructs capacity around Hungary, Poland, Sweden, FInland, France, and German automotive integration, sourcing green hydrogen and critical raw minerals including lithium, cobalt, and rare earths through EU partnerships with Namibia, the Democratic

Republic of Congo, and Kazakhstan signed in 2022-2023. Turkey will serve as a bridge, assembling EVs and batteries for both European and Middle Eastern markets.

The Americas bloc leverages USMCA and IRA provisions (despite Trump-era modifications) to build North American capacity. Integrated supply systems will be developed to link Canadian mining, US refining and battery production, and Mexican vehicle assembly. Despite higher costs, regional supply ensures resilience and compliance with domestic content rules.

Cross-bloc dynamics: Each bloc develops, in parallel, integrated supply chains, proprietary battery chemistries, charging standards, and vehicle platforms with limited interoperability. Chinese EV exports are likely to face 50–100% tariffs in Americas and EMEA markets, prompting BYD, Geely, and others to establish local assembly that qualifies for regional treatment. Western automakers will maintain selective China operations but increasingly serve Asian markets through local subsidiaries. By 2030, EV adoption might reach 75% in China, 50% in Europe, 18% in the US, and 25% in Southeast Asia—slower overall progress than under integrated trade scenarios but steady regional growth.

***Apparel***

Trade regionalization accelerates, driven by tariffs, sustainability requirements, and supply chain risk management. The Asian bloc under RCEP eliminates tariffs on textile inputs, cementing China's role as supplier of fabrics, yarns, and machinery to ASEAN and South Asian manufacturers. Major Chinese textile companies including Texhong, Shenzhou International, and Huafu Fashion have already expanded to Vietnam, Cambodia, Bangladesh, and Ethiopia. Chinese apparel brands such as ANTA, Bosideng, and Urban Revivo, and digital-first brands like Shein, Cupshe, Cider, and BloomChic will deepen market penetration across Asian and Belt and Road markets.

The EMEA bloc constructs a vertically integrated chain linking Turkish textile production, North African assembly (Egypt, Morocco, Tunisia, Ethiopia), European design and branding, and Middle Eastern cotton (Egypt, Uzbekistan). The EU's Digital Product Passport (DPP) requirements and the likely CBAM extension to textiles (post-2026) favour regional suppliers who can demonstrate compliance, reducing Asian imports from over 60% to 35% of EMEA consumption by 2030.

The Americas bloc operationalizes nearshoring at scale through Mexico and Central America (Guatemala, Honduras, El Salvador), benefiting from USMCA duty-free access, shorter lead times, and lower transport emissions. Brazilian cotton will anchor the hemisphere, while US brands will maintain design and quality control.

Cross-bloc trade persists for specialized items such as technical outerwear and performance fabrics, where quality and technology justify premium prices. Overall apparel costs and

prices will rise in the Americas and EMEA due to higher costs in the regions, but consumer demand for transparency and sustainability will support the shift.

***Medical Devices***

Regional ecosystems emerge along technological and cost tiers. The Asian bloc sees Chinese manufacturers—led by Mindray, United Imaging Healthcare, and others—dominate volume production, focusing on consumables, mid-range imaging equipment, and patient monitoring systems. Production will concentrate in China's coastal provinces (Jiangsu, Guangdong, Zhejiang) and extend to emerging locations such as Malaysia, Vietnam, Thailand to reduce cost and benefit from market proximity. ASEAN markets and Belt and Road countries such as Pakistan, Bangladesh, and African nations will rely overwhelmingly on Asian suppliers for affordable medical devices.

The EMEA bloc specializes in premium innovation—German, Swiss, Dutch, and French firms lead in surgical robotics, advanced diagnostics, and precision instruments. Production will clusters around centres of medical excellence (Germany's Bavaria, Switzerland's Medtech Valley, Netherlands' Brainport Eindhoven, Italy’s Mirandola Biomedical District), with component sourcing from Eastern European facilities (Poland, Czechia). African markets will see competition between European suppliers and Chinese affordability.

The Americas bloc balances domestic high-tech production with nearshore cost optimization. US firms will maintain leadership in AI-powered diagnostics, minimally invasive surgical tools, and cardiovascular devices, while shifting component manufacturing to Mexico, Costa Rica, and Dominican Republic under USMCA provisions. Canada will specialize in digital health technologies and wearable medical devices. Latin American markets will increasingly source from regional suppliers, reducing Asian dependence.

Cross-bloc technology transfers face growing restrictions, limiting Chinese access to cutting-edge Western innovations (AI-diagnostics, surgical robotics). Duplicate R&D investments will increase, and regulatory fragmentation will create barriers to global scale.

***Scenario Implications***

This scenario increases costs through duplicate capacity, reduces economies of scale, slows innovation through limited knowledge sharing, and creates inefficiencies from non-interoperable standards. However, it enhances resilience by reducing single-country dependencies and provides strategic autonomy for critical products. Winners include countries positioned as regional hubs (Mexico, Poland, Thailand, Morocco) and firms with multinational production footprints. Losers include globally integrated firms unable to replicate capabilities across regions and smaller countries excluded from major blocs.

## Scenario 2: Resilient Diversification—'China Plus N' at Scale

This scenario envisions pragmatic interdependence where firms systematically diversify beyond China while maintaining significant Chinese operations. "China Plus N" evolves from a risk mitigation tactic into a mature operational model with globally distributed production networks.

***Solar PV***

Diversification makes gradual progress against entrenched Chinese advantages. Southeast Asian countries (e.g., Vietnam, Malaysia, Thailand) develop significant cell and module capacity, often through Chinese investment but with local ownership stakes and technology transfer. India builds substantial capacity under the PLI scheme, serving domestic and South Asian markets. MENA is emerging as a significant hub through foreign investments. The US achieves meaningful panel assembly and limited cell production, though upstream polysilicon and wafer stages remain heavily dependent on imports. Europe maintains specialized capacity in advanced technologies (heterojunction, tandem cells) even if lacking cost-competitive mass production. This distributed footprint allows firms to serve regional markets while optimizing for tariffs, carbon regulations, and local content requirements. Despite diversification, China will continue to be a significant player in the global solar PV supply chain, especially in upstream segments, and will maintain technology leadership. China's global share might decrease from 90% to 70-75% in upstream stages and 60-70% in downstream stages, still dominant but no longer monopolistic.

***Electric Vehicles***

A more balanced outcome envisions pragmatic interdependence. Governments and firms diversify suppliers to enhance resilience, yet global trade and investment continue under moderated competition. By 2030, multiple regional production centres—China, North America, Europe, India, and ASEAN—coexist, each with significant battery capacity and localised mineral processing. Cross-investment remains common: Chinese producers operate plants in Europe and the US, while Western and Japanese automakers maintain ventures in China. Supply risks are managed through redundancy rather than decoupling. Global cooperation on standards, recycling, and digital “battery passports” improves transparency and cost efficiency. Innovation flourishes through cross-border R&D, driving average battery costs toward US$70 per kWh and enabling EVs to reach price parity with internal-combustion cars in most markets by 2030. This scenario delivers the fastest technological progress and broadest market access, provided that trade stability and climate cooperation are maintained.

***Apparel***

'China Plus N' matures into stable multi-sourcing ecosystems. China's share in global garment exports will decline further from 30% to 20%, with share increases distributed across Bangladesh, Vietnam, Cambodia, India, Pakistan, Turkey, Egypt, Ethiopia, and Central America. However, China will increase its share in textile production, raw materials processing, and machinery manufacturing, as the country moves up the value chain. Chinese firms will invest in and manage factories across Asia, Africa, and Americas, creating "distributed Chinese supply chains" where China provides capital, technology, components, and brands, and evolving from direct manufacturer to ecosystem enabler. Major apparel brands will typically source from more than a dozen countries with no single country exceeding 25% of procurement.

***Medical devices***

'China Plus N' manifests through tiered diversification by product complexity. High-value diagnostic imaging, surgical robots, and implantables will remain concentrated in developed markets (US, Europe, Japan, Singapore) with R&D-intensive production. Mid-tier devices (monitors, infusion pumps, diagnostic equipment) will see balanced production across China, India, Southeast Asia, and Americas nearshoring hubs. Low-complexity devices and consumables will spread widely to cost-competitive locations including Vietnam, Malaysia, India, Ethiopia, Kenya, and Mexico. No country will dominate any segment with more than 40% share; and firms will maintain at least three production locations per product category.

***Scenario Implications***

This scenario delivers optimal outcomes—it balances efficiency with resilience, maintaining global economies of scale while spreading geopolitical and operational risks. Innovation continues through international collaboration and competition. Regulatory and standards convergence improves transparency and interoperability while preserving competitive dynamism. Supply chain management complexity increases substantially, requiring sophisticated systems for visibility and coordination. Winners include multinational firms with strong supply chain capabilities and countries offering specific competitive advantages. Losers include countries and regions lacking distinctive competitive advantages.

## Scenario 3: ESG-Driven Transformation—Sustainability as Strategic Imperative

In this pathway, environmental, social, and governance requirements—transitioning from voluntary commitments to enforceable regulations—reshape supply chain geography and operations through multiple simultaneous mechanisms. Rather than simply driving localization, ESG imperatives trigger diverse strategic responses including migration to clean-

energy regions, investment in circular infrastructure, enhanced transparency systems, and process innovation.

***Solar PV***

Carbon footprint becomes a competitive differentiator. CBAM will ultimately apply carbon costs to imports of materials including steel and aluminum from 2026. Solar panel imports will face levies based on embedded carbon, favouring panels from low-carbon polysilicon sources (e.g., hydropower-based operations in Norway, Canada, or Southwest China's Sichuan/Yunnan regions) and renewable-powered cell manufacturing. Meanwhile, panel recycling infrastructure is developing rapidly. JinkoSolar operates a 12MW pilot PV recycling line in China achieving 92% overall recycling rate and 95% recovery for embedded metals. Europe establishes recycling facilities in Germany, France, and Italy under Extended Producer Responsibility schemes. These recycling hubs process panels from surrounding countries, achieving economies of scale while enabling circular material flows.

***Electric vehicles***

ESG drives transformation across multiple dimensions. The EU Batteries Regulation's mandates—requiring by 2031 that batteries contain 16% recycled cobalt, 6% recycled lithium, and 6% recycled nickel—will drive development of regional circular economy hubs rather than fully localized systems. Europe establishes large-scale battery recycling facilities in Poland, Germany, and Belgium serving the entire continent. North America develops centres in Ontario and southwestern US. China builds capacity in Jiangxi, Hubei, Sichuan and Guangdong provinces. These regional hubs would achieve economies of scale impossible with fully localized recycling.

The CBAM charges favour low-carbon production wherever located, not necessarily nearby production. The result will be a complex geography where different value chain stages locate based on clean energy availability, recycling infrastructure, regulatory strength, and innovation ecosystems rather than simple proximity to markets.

***Apparel***

Sustainability transitions from aspiration to legal obligation. EU regulations including ESPR, the EU Strategy for Sustainable and Circular Textiles, and *Waste Framework Directive* mandate DPPs, require minimum recycled content, ban destruction of unsold textiles, and impose EPR fees. An extension of the CBAM to textiles will penalize carbon-intensive dyeing and synthetic fiber production, driving shifts toward renewable-powered manufacturing. Suppliers will invest massively in green technologies and process optimization. Major manufacturers will increasingly adopt renewable energy, closed-loop water systems, and advanced dyeing technologies to maintain competitiveness in ESG-conscious markets. Recycled and bio-based materials will also gain traction. Recycled polyester from PET bottles

and textile waste will grow, while bio-based alternatives including Tencel and Modal (derived from wood pulp) will expand. Living wage requirements and gender equality standards (pushed by STAR Network and national legislations) will favour production in countries with strong labour protections and enforcement rather than lowest-cost locations.

***Medical devices***

ESG drives differentiated strategies by product type. Capital equipment (imaging systems, surgical robots) will increasingly incorporate circular economy principles—manufacturers offer equipment-as-a-service models where hospitals lease rather than purchase, with manufacturers responsible for maintenance, upgrades, and eventual recycling. Medtronic's commitment to net-zero emissions across all scopes by 2045 will continue to drive supplier selection based on verified carbon footprints rather than geography alone. Waste reduction initiatives will transform product design and supply chains. Reusable surgical instruments will increasingly replace single-use plastics where clinically appropriate, requiring sterilization infrastructure rather than disposal systems.

ESG becomes a healthcare procurement criterion. Hospitals are increasingly adopting sustainable procurement policies prioritizing suppliers with carbon-neutral manufacturing, fair labour practices, and circular economy integration. ESG differentiation becomes brand value: hospitals publicize sustainable sourcing to attract environmentally conscious patients and staffs.

Manufacturing clusters will emerge in regions with strong governance and verified ESG standards rather than simply nearby markets. Countries such as Singapore, Ireland, and Costa Rica will attract investment in medical device manufacturing and innovation not just by offering market access, but also through robust regulatory oversight, transparent labour practices, and comprehensive environmental compliance that enable credible ESG reporting.

***Scenario Implications***

This scenario increases short-term costs through compliance investments, but generates long-term competitive advantages through resource efficiency, waste reduction, brand reputation, and risk mitigation. Winners include companies with advanced ESG capabilities and verification systems, circular economy technology leadership, and strong governance frameworks enabling credible compliance. First movers gain competitive advantages through brand differentiation and positioning ahead of regulatory requirements. Losers include firms unable to afford compliance investments, countries with weak environmental governance, and regions lacking recycling and circular economy infrastructure.

## Navigating Multiple Concurrent Realities

These three scenarios are not mutually exclusive alternatives. The future will blend elements across all three scenarios—partial regionalization around three blocs with active internal trade, widespread diversification maintaining selective Chinese integration, and universal tightening of ESG requirements.

For businesses, adaptability is paramount: multi-sourcing strategies balancing cost and resilience, regional production footprints meeting local requirements, deep local partnerships for navigating fragmented regulatory environments, transparent supply chain management enabling regulatory compliance, and early ESG integration capturing premium markets. Technology investments and ESG capabilities separate leaders from laggards: AI-enabled supply chains, responsible sourcing, green manufacturing processes, advanced recycling systems, and digital traceability become competitive necessities rather than optional enhancements.

For policymakers, the challenge is balancing domestic industrial competitiveness with international cooperation. Strategic policy support for domestic capacity development must couple with trade openness among trusted partners to avoid costly fragmentation. Stable and predictable regulatory frameworks are also essential to sustain investor confidence—sudden reversals, as in US IRA modifications and subsidy withdrawals, create uncertainty that affects investment decisions. Multilateral cooperation on standards, harmonized rules, and data sharing would mitigate compliance burdens and improve transparency, while ensuring transitions align with climate and development goals. Furthermore, supporting workforce development and infrastructure investments in clean energy, digital connectivity, and recycling systems creates foundations for resilient, sustainable, and competitive supply chains regardless of which scenario predominates.

## Conclusion

The global supply chain landscape is entering a period of fundamental restructuring, shaped by forces that extend beyond economics into geopolitics, technology, and sustainability. The analysis of global supply chains across electric vehicles, apparel, solar PV, and medical devices reveals both common patterns and sector-specific dynamics that will shape the coming decade.

Common themes emerge across sectors: (1) Geopolitical fragmentation is creating regional supply chain blocs with varying degrees of interconnection; (2) Technology transformation driven by AI, automation, and advanced materials is fundamentally restructuring value creation and competitive dynamics; (3) ESG requirements are transitioning from voluntary aspirations to mandatory operational frameworks that reshape sourcing decisions; (4) China's structural advantages in manufacturing scale, vertical

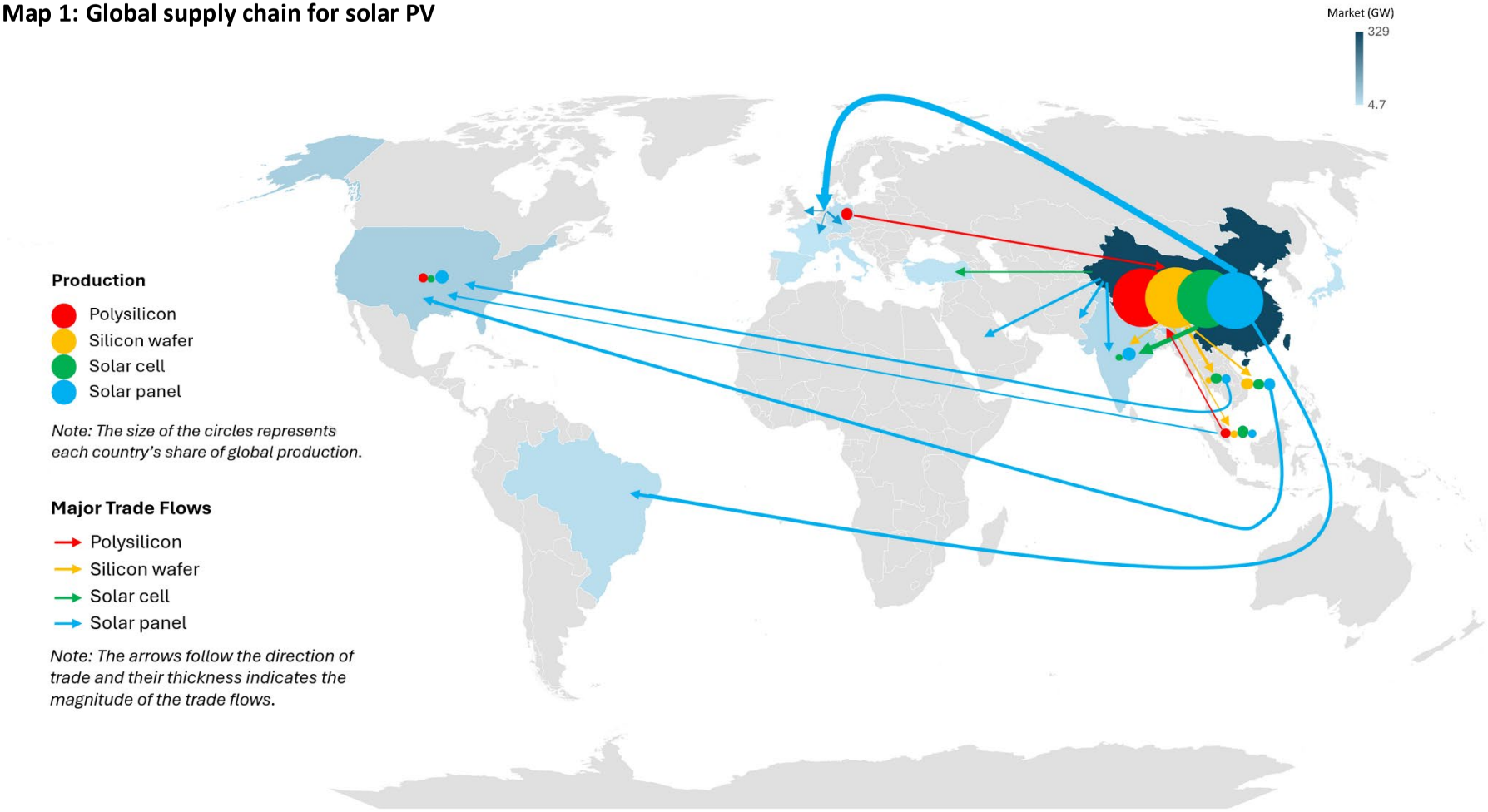
integration, technological capabilities, and cost competitiveness ensure continued dominance even as diversification occurs; and (5) Diversification is occurring but gradually, constrained by economic realities, infrastructure gaps, and ecosystem dependencies.

Success in this transforming landscape requires strategic vision, operational agility, technological leadership, and collaborative partnerships. Companies that embrace multi-sourcing strategies, harness technological innovations swiftly, and embed ESG principles firmly will gain first-mover advantages to build resilient, intelligent, and sustainable global supply chains capable of adapting to an unpredictable world. Policymakers who balance competitiveness with cooperation, provide stable and predictable long-term frameworks, and invest in enabling infrastructure will position their countries to thrive in the evolving global economy.

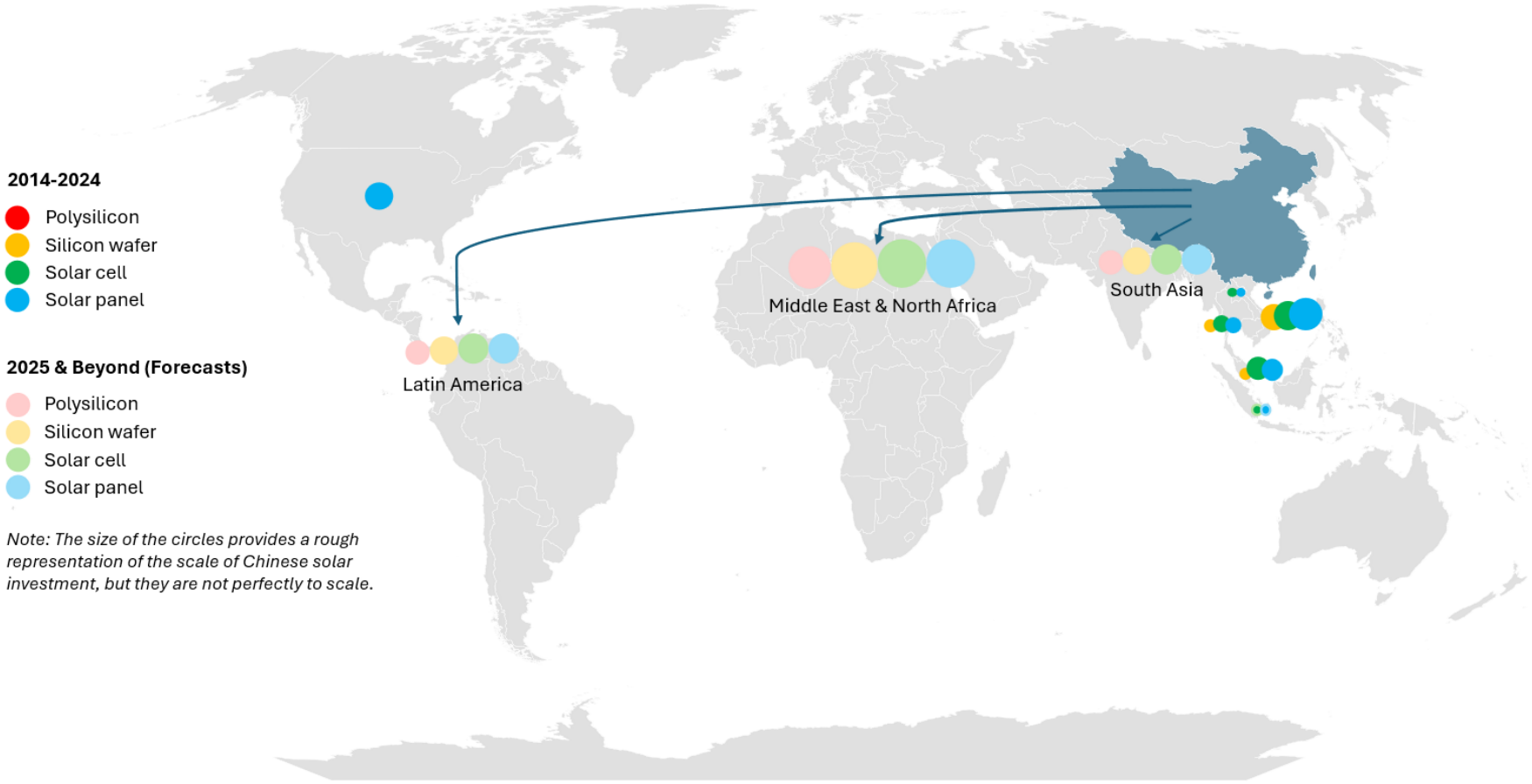
While the path forward remains uncertain—marked by policy volatility, technological disruption, and geopolitical rivalries—the direction is clear: supply chains will become more regionalized yet remain globally interdependent, more technologically sophisticated yet still constrained by economic fundamentals, and more sustainable yet still driven by cost competitiveness. The companies and countries that navigate this transformation successfully will be those that recognize these trade-offs, adapt pragmatically to evolving realities, and remain committed to building supply chains that serve not only shareholder value but also broader economic resilience and societal well-being. How this transition unfolds will define winners and losers in the global economy for the next generation.

# Appendix

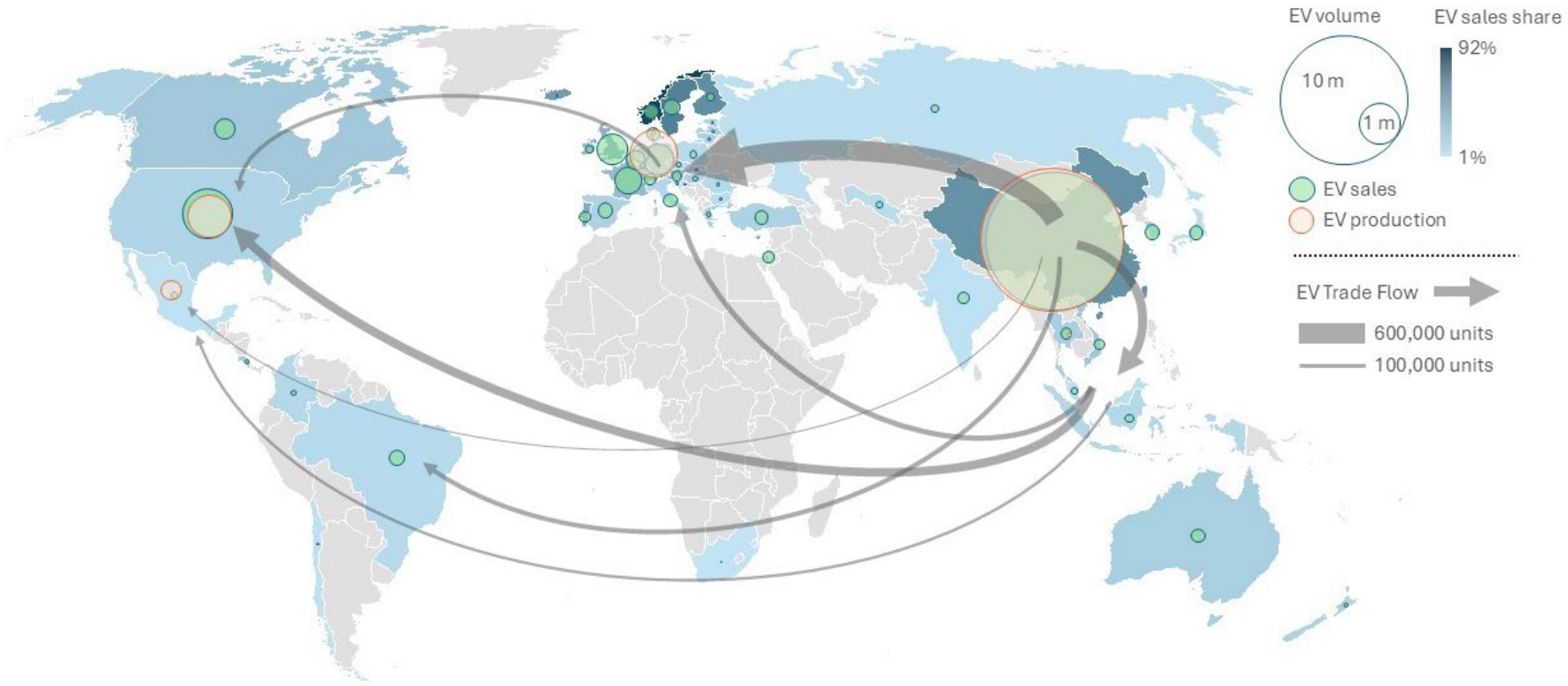
## Map 1: Global supply chain for solar PV



## Map 2: Globalization of Chinese solar manufacturing

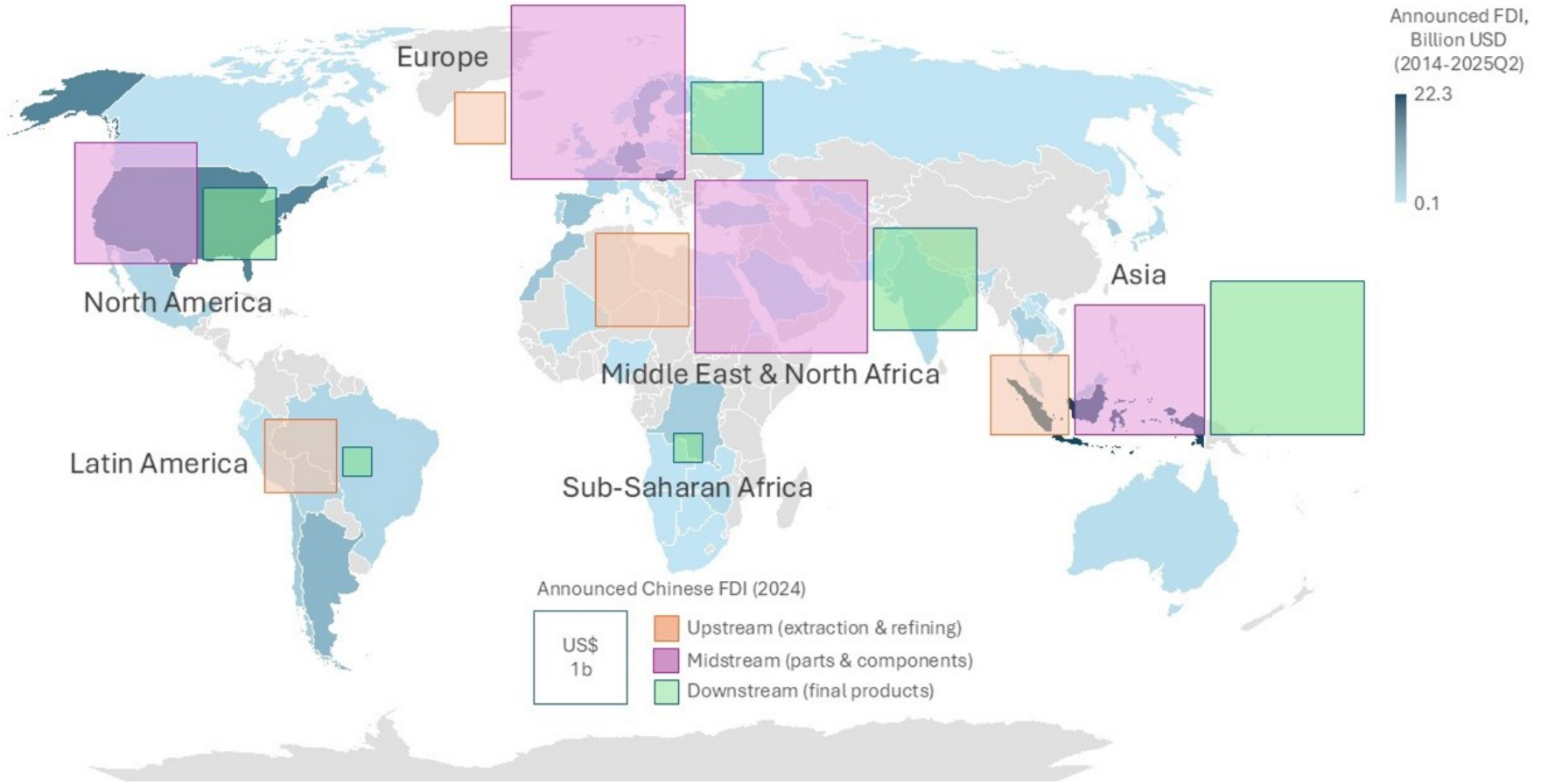


## Map 3: Global EV trade flows



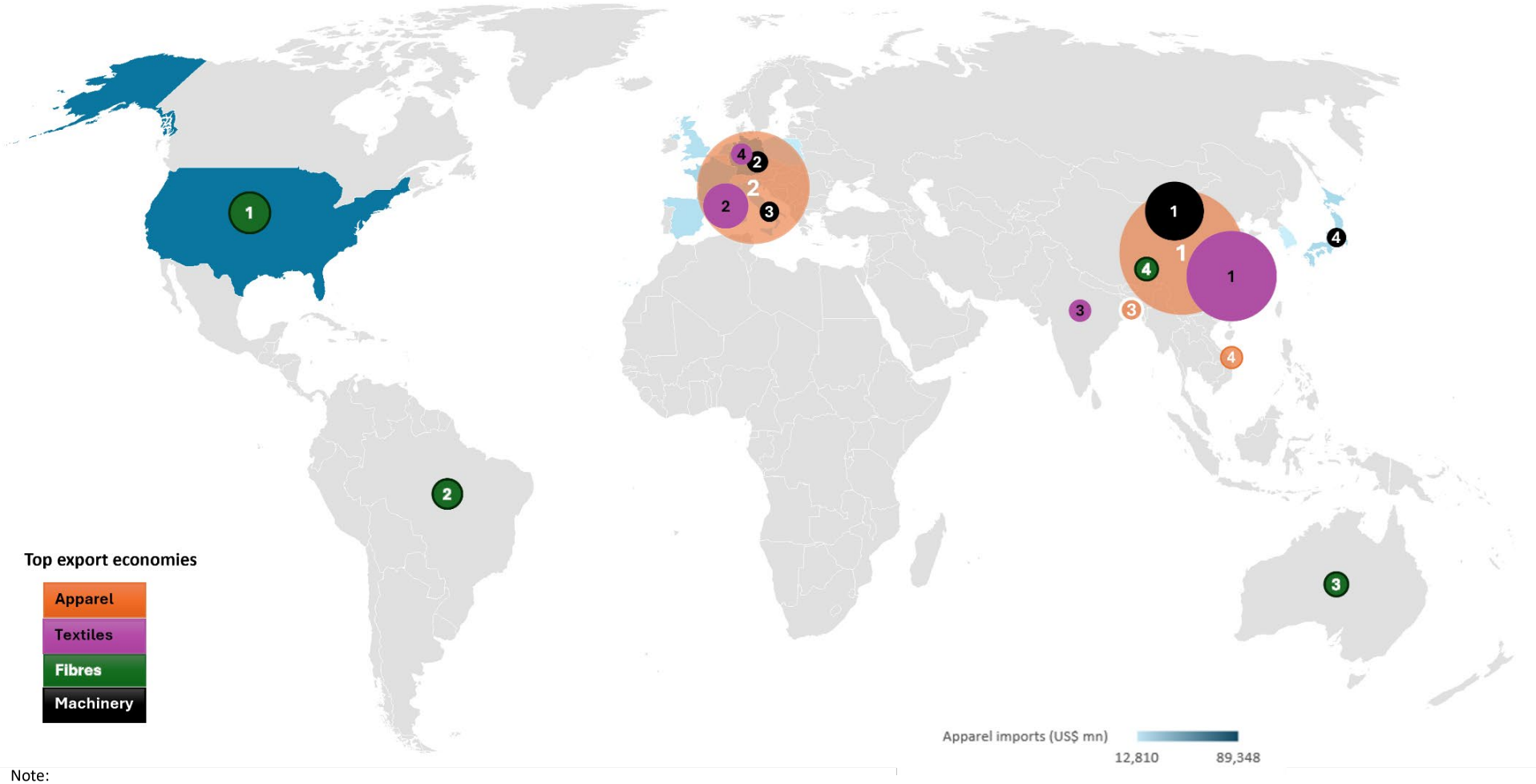

Note: 'EV sales share' here refers to the proportion of domestic BEV and PHEV passenger car sales (by units) relative to total passenger car sales.
Source: IEA, GMK, Mexico Business News, Shanghai Metal Market, compiled by LFSCI

**Map 4: Announced Chinese FDI in the global EV supply Chain**




Source: Rhodium Group, compiled by LFSCI

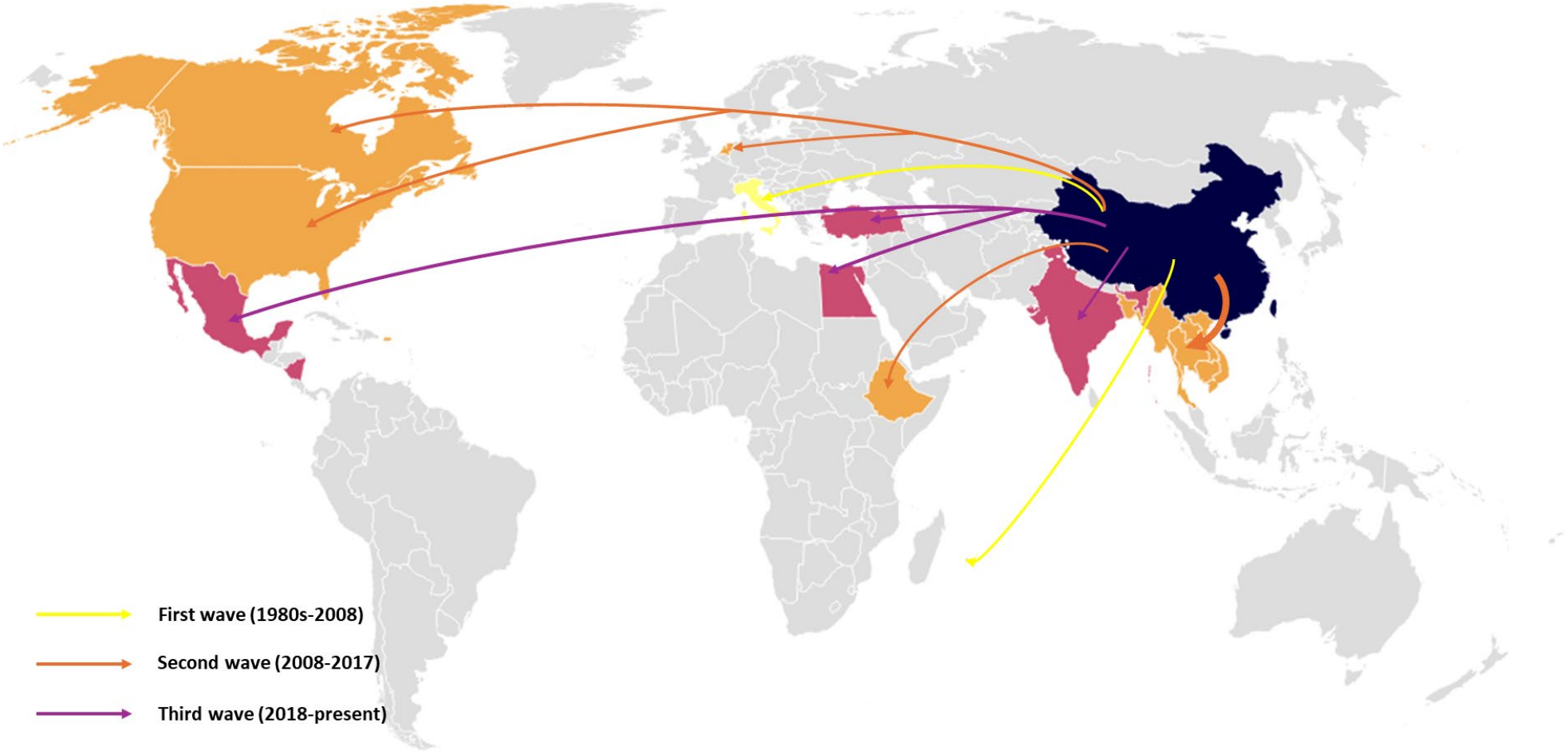
## Map 5. Locations of top suppliers along the global apparel supply chain




Note:

1. Numbers indicate ranks by export value within each apparel segment.
2. Both the EU as a whole and individual EU countries in the top ranks of each apparel segment are marked on the map.

**Map 6. Locations of top suppliers along the global apparel supply chain**

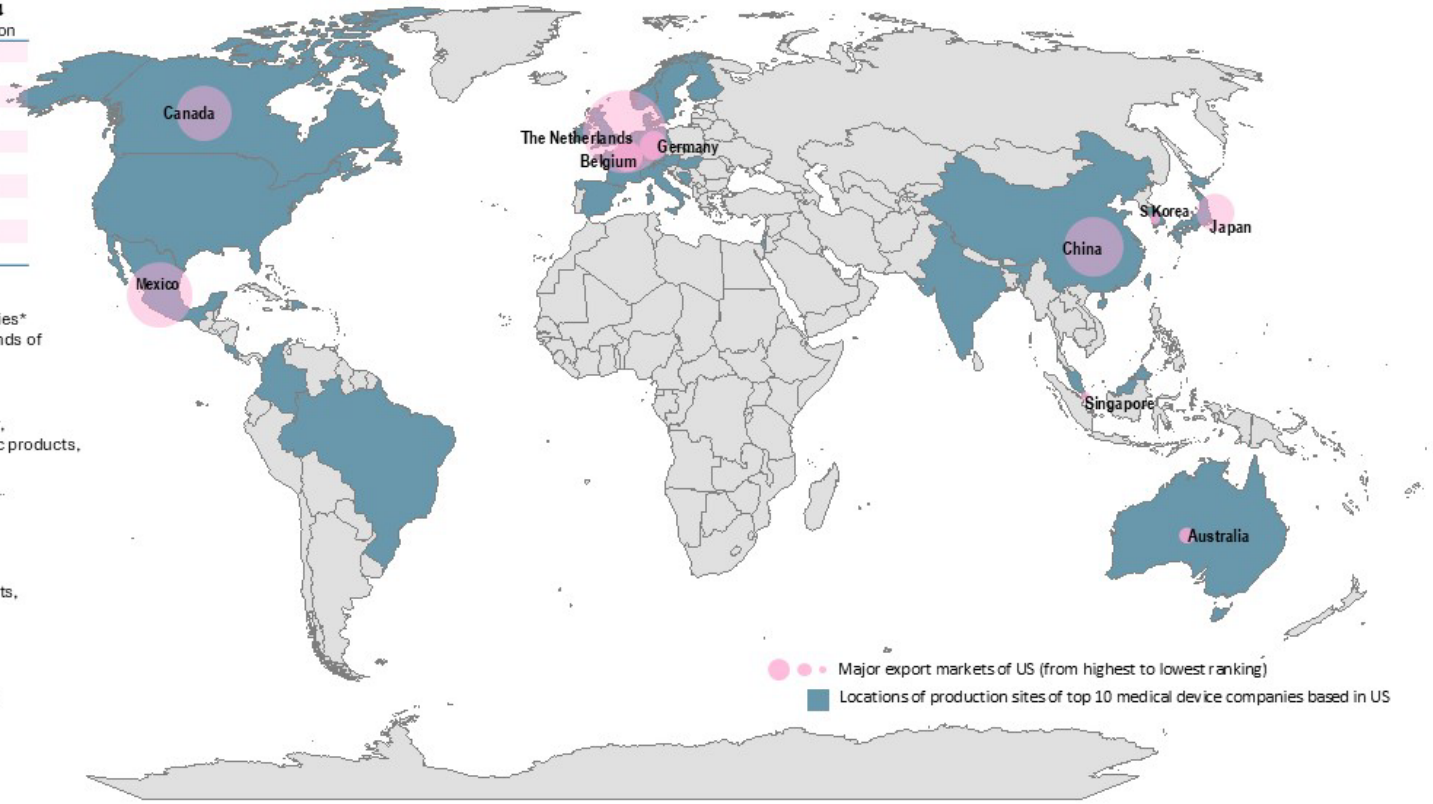


## Map 7. Major export markets of US's health equipment, 2024

| Major export markets of US | Export value in 2024 US$ billion |
|---|---|
| The Netherlands | 6.14 |
| Mexico | 4.67 |
| China | 3.46 |
| Canada | 3.24 |
| Japan | 2.72 |
| Belgium | 2.15 |
| Germany | 2.06 |
| Australia | 1.17 |
| South Korea | 0.84 |
| Singapore | 0.77 |

The top 10 medical device companies* based in the US produce various kinds of medical devices, including:

- anesthesia & critical care,
- biosurgery, biosciences,
- cardiac devices, cardiovascular,
- craniomaxillofacial and thoracic products,
- dental and spine devices,
- diabetes care,
- diagnostics,
- infusion systems,
- life care solutions,
- neuroscience devices,
- orthopedics, orthopedic implants,
- renal therapies,
- respiratory care,
- rhythm management,
- sleep apnea devices,
- spine devices, surgical devices,
- thoracic products,
- ultrasound,
- urology,
- vascular devices, and
- vision categories.




Note: For the company list, please refer to Table 6 of the *Medical Device Report.*

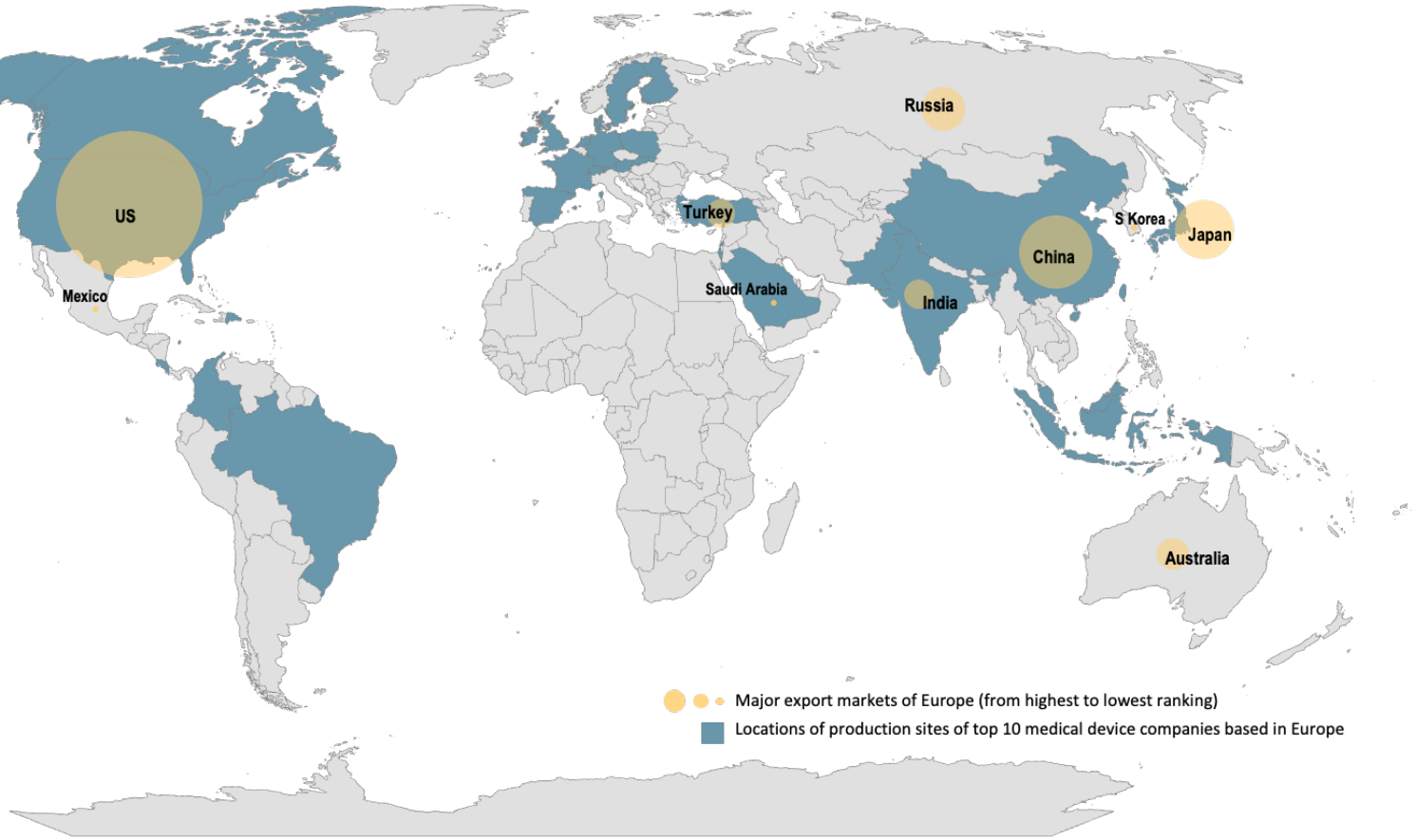
Source: Statista, company websites

## Map 8. Major export markets of Europe's medical technology devices, 2023

| Major export markets of Europe | % of export value in 2023 |
|---|---|
| US | 40.4% |
| China | 11.0% |
| Japan | 5.4% |
| Russia | 3.6% |
| Australia | 2.8% |
| India | 2.3% |
| Turkey | 2.1% |
| South Korea | 2% |
| Mexico | 2% |
| Saudi Arabia | 2% |

The top 10 medical device companies* based in Europe produce various kinds of medical devices, including:

- advanced therapies,
- advanced wound care,
- clinical nutrition,
- connected care,
- dialysis equipment,
- hearing devices and solutions,
- implant and regenerative dentistry,
- infection control,
- infusion therapies,
- laboratory diagnostics,
- medical imaging,
- ophthalmology,
- orthopedics,
- patient monitoring devices,
- sports medicine, and
- surgical devices.




* Note: For the company list, please refer to Table 7 of the *Medical Device Report.*

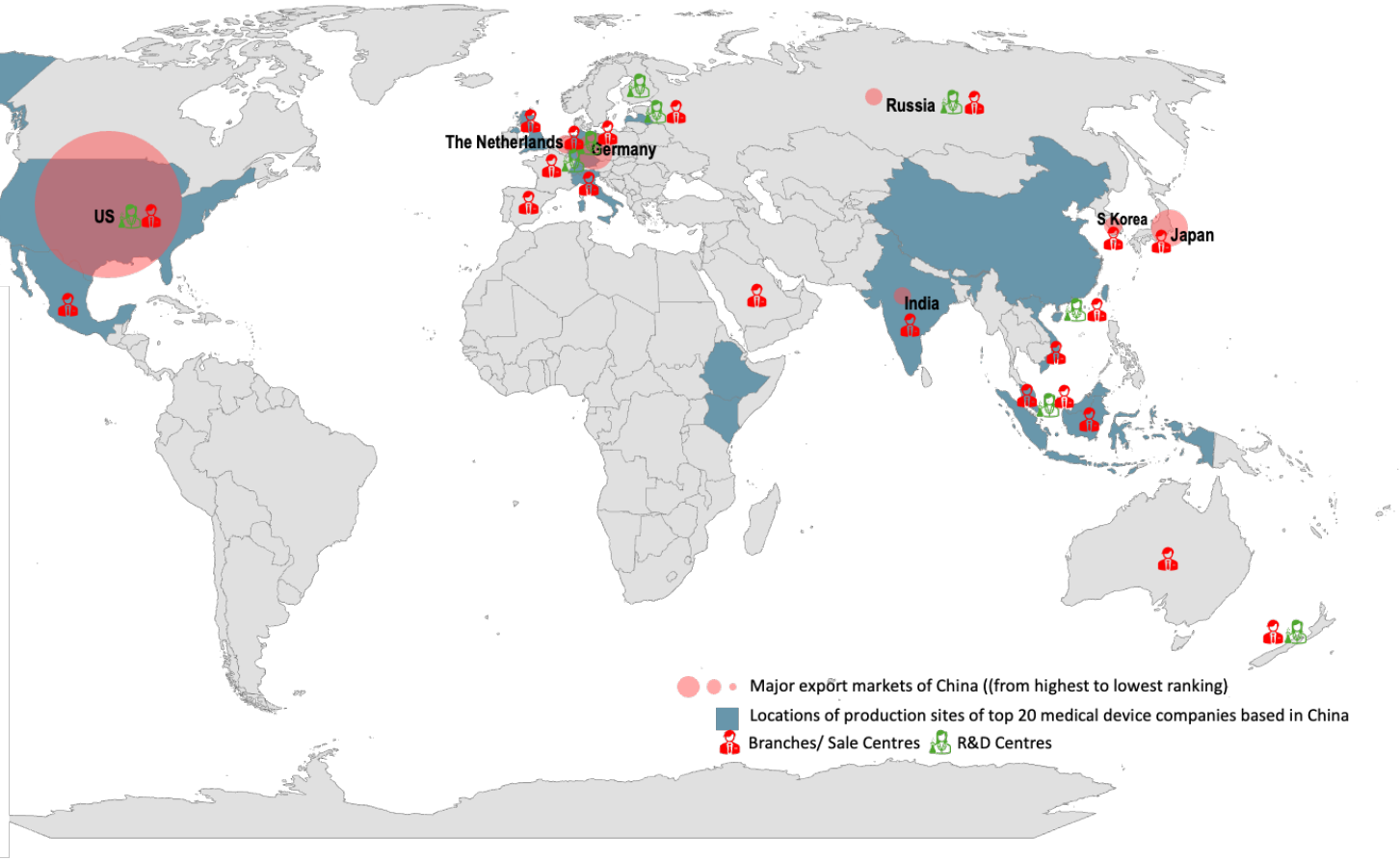
Source: Statista, company websites

## Map 9. Overseas business of China's leading medical device companies, 2024

| Major export markets of China | % of export value in 2024 |
|---|---|
| US | 25.0% |
| Japan | 5.9% |
| Germany | 5.7% |
| The Netherlands | 3.3 |
| Russia | 3.2 |
| South Korea | 2.9% |
| India | 2.9 |

The top 20 China's medical device companies* produce various kinds of medical devices, including

- blood glucose monitor,
- cardiovascular,
- clinical nutrition,
- connected care,
- dialysis equipment,
- cardiovascular consumables,
- glasses bottles,
- gloves,
- hearing devices and solutions,
- home medical equipment,
- imaging equipment,
- in vitro diagnostic,
- life support devices,
- medical consumables,
- ophthalmology,
- orthopedic materials,
- patient monitoring devices,
- pharmaceutical equipment,
- respiratory therapy,
- sensors, smart devices,
- vascular interventional therapy materials, and
- wound care.




Note: For the company list, please refer to Table 14 of the *Medical Device Report*.

Source: Frost & Sullivan, company websites

# Industry Summaries

# Where the Sun Shines: The Changing Landscape of the Global Solar Supply Chain

## Executive Summary

Solar power, the third largest renewable energy source in global electricity generation, has experienced remarkable growth in recent years. Driven by a significant expansion in solar photovoltaic (PV) installed capacity, the contribution of solar power to global electricity generation increased to 6.9% in 2024. This upward trend is expected to continue due to the improving cost-effectiveness of solar energy, a wider range of applications, and the pressing need for renewable energy sources to combat climate change and ensure energy security in an increasingly complex geopolitical landscape.

Solar PV is the dominant technology used in solar power generation, with most solar panels in use being crystalline silicon panels. These solar panels are produced by a global supply chain that encompasses the entire production cycle, from the mining of raw materials (i.e., quartz) and the refining of polysilicon to the manufacturing of solar cells and the assembly of solar panels. The global aspect of the solar supply chain further reveals a complex network intricately woven into the fabric of global economic and political dynamics, reflecting broader trends in geopolitics, domestic industrial policies, market forces, technology, and sustainability.

In recent years, geopolitical tensions and trade protectionism have escalated, resulting in increased import tariffs and other duties on solar products. Meanwhile, supportive domestic industrial policies, such as financial incentives and support mechanisms, could bolster local solar production. Free trade agreements (FTAs), on the other hand, could help reduce or eliminate tariffs on solar inputs and components among signatory countries, thereby facilitating solar sourcing based on cost considerations and the development of regional solar supply chains.

The supply of raw materials and components, along with production capacity and costs, are crucial determinants of competitiveness within the solar supply chain. Countries that rely on imported raw materials and solar inputs render their solar supply chain vulnerable to various risks. Meanwhile, countries with high production costs may find themselves at a disadvantage in the global or even the domestic market and may need to depend on imports for their domestic solar deployment.

Significant advancements in solar technology have been made over the past decade. The rapid and widespread adoption of new technologies could not only lower costs and enhance competitiveness but also help set global technological trends in the solar industry.

Environmental, Social, and Governance (ESG) factors are increasingly shaping the solar supply chain landscape. Growing awareness of climate change and the shift towards renewable energy are driving investments in solar technologies and manufacturing, while also influencing the formulation of energy policies.

In terms of geography, China has been the undisputed leader in solar manufacturing over the last decade. It has leveraged its production scale, vertically integrated supply chain, technological prowess, and cost efficiency, along with government support, to excel in all facets of the global solar supply chain. While protectionist duties imposed by the US and other countries since the early 2010s have prompted some shifts in solar cell and panel manufacturing from the Chinese mainland to regions like Southeast Asia, China still controls approximately 85% of panel production and over 90% of upstream manufacturing stages.

Looking ahead, the global solar PV supply chain landscape is undeniably undergoing major transformations, with rising trade tensions and government interventions likely to further fragment the global solar supply chain. On one hand, newly imposed and potential US duties on imported solar cells and panels from Southeast Asian countries may hinder their solar manufacturing industry. On the other hand, the US and India, buoyed by trade protectionist measures and substantial government support, are emerging as strong contenders in the solar manufacturing arena, attracting investments from both domestic and international players seeking diversification away from China.

Despite these shifts, we expect China to maintain its absolute leadership in the global solar PV supply chain for the foreseeable future, thanks to its competitive production costs, technological leadership, and complete solar supply chain. China’s pivotal role is further exemplified by the globalization of its solar manufacturing, with investments diversifying beyond Southeast Asia to the Middle East, Africa and other countries.

# Expansion and Diversification: Securing EV Supply Chains Amid Global Fragmentation

## Executive Summary

**Electric vehicle (EV) adoption has accelerated globally between 2023 and 2025**, with EV sales reaching about 17 million in 2024, accounting for over 20% of new car sales worldwide. The total EV fleet on the road grew to around 58 million by the end of 2024, more than triple the stock just three years prior. This surge has been led by China, Europe, and the US, which together made up 95% of 2024 EV sales. Major emerging markets like Southeast Asia and Latin America are witnessing even more rapid growth—for example, Thailand's EV sales share surged to 13% in 2024, up from just 2% two years prior, while Brazil's EV sales more than doubled to around 125,000 units, capturing about 6% of its market. Despite this progress, EVs still represent only around 4.5% of the 1.6 billion vehicles on the road globally in 2024, leaving substantial room for growth.

EV supply chains have expanded and evolved in response to this demand. **Batteries remain the costliest component of EVs, though their share of total vehicle cost has fallen** to around 30–40% in most mainstream models and is expected to decline further. **Critical minerals are unevenly distributed**: Australia, China and Chile provide over three-quarters of lithium; the Democratic Republic of Congo (DRC) supplies nearly 70% of cobalt; and Indonesia has become the dominant producer and processor of nickel for battery use. China, meanwhile, plays a central role in refining—processing around 60% of lithium, 70% of cobalt, and up to 90% of rare earth elements—as well as producing most battery-grade graphite. **Ensuring stable mineral supply has therefore become a strategic priority**, with governments and companies pursuing diversification through new mining projects and investing in alternatives such as lithium-iron-phosphate (LFP) and sodium-ion batteries to reduce reliance on scarce materials.

At the same time, **geopolitical tensions and trade barriers are reshaping supply chains**. The intensification of the US-China rivalry, European trade investigations into Chinese EV imports, and new export controls on minerals such as graphite, gallium, and germanium have heightened disruption risks. In response, automakers and battery producers are shifting towards **localization of production**, **"friend-shoring"**, and **vertical integration**. These strategies aim to reduce exposure to geopolitical shocks, diversify supply, and strengthen resilience, even if they sometimes raise costs or duplicate capacity.

**Leading manufacturers have also expanded their global production footprints, but China remains the manufacturing powerhouse.** In 2024, it produced around 12.9 million EVs—over 70% of global output—and sold nearly the same number domestically, accounting for about 60-75% of global EV sales depending on definitions. Chinese firms dominate: BYD sold more than 4.27 million EVs in 2024, topping the global ranking, while CATL supplied about 38% of the world's EV batteries, with BYD ranking second at 17.2%. The world's second-largest EV seller, Tesla, delivered 1.79 million units in 2024, retaining its lead in battery-electric vehicles (BEVs). European manufacturers such as Volkswagen continued to expand EV sales, particularly in Europe, though global growth remains more modest compared with China's rapid scale-up. A landmark came in 2023 when the Tesla Model Y became the world's top-selling car of any type, with over 1.2 million units sold worldwide, signalling EVs' entry into the automotive mainstream.

**Looking forward, policy and technology will be decisive in shaping the next phase of the EV supply chain.** In the US, the *Inflation Reduction Act* (IRA), enacted in 2022 to incentivise local EV and battery production, is under review by the new administration in 2025, creating uncertainty over the future of tax credits and domestic content rules. Europe has moved ahead with stringent sustainability measures: the EU Batteries Regulation (enacted in 2023, phased in from 2024) mandates carbon footprint disclosure and recycled content, while the *Carbon Border Adjustment Mechanism* (CBAM) entered a transitional reporting phase in 2023-2025 and will apply carbon costs to imports such as steel and aluminium from 2026. China is pressing ahead with its *New Energy Vehicle (NEV) Industry Development Plan (2021-2035)* and, in mid-2023, extended purchase tax exemptions for EVs through 2027 to sustain domestic demand. India, meanwhile, is strengthening its EV ecosystem—especially for two- and three-wheelers.

Against this backdrop, **three plausible mid-term scenarios emerge for the late 2020s**. In a **Fragmented Blocs** world, US-China decoupling leads to distinct regional supply spheres; in a **Resilient Diversification** outcome, supply chains remain global but with broader sourcing and less dependence on any one country; while in an **ESG-Driven Localization** pathway, sustainability and ethical requirements force greater localization, recycling, and reshaped material sourcing. Each carries different implications for cost, innovation, and resilience. To thrive, businesses will need agility—investing in next-generation technologies such as solid-state batteries and AI-driven manufacturing, while forging strategic partnerships. Policymakers, in turn, must balance industrial competitiveness with international cooperation to keep the EV transition on track with climate goals while securing supply chain integrity.

# Threading a Green and Intelligent Tapestry: The Apparel Supply Chain Landscape in a Turbulent World

## Executive Summary

Apparel is an essential commodity and a key value-creating sector of the global economy. The apparel market size is estimated at US$1.8 trillion in 2024 and is expected to reach US$2.0 trillion by 2029. Apparel supply chains are among the world's most globalized, spanning raw material producers, ginners, spinners, weavers, dyers, designers, and garment manufacturers, before reaching consumers via wholesalers, retailers, and e-commerce platforms. It is estimated that approximately 430 million workers are employed globally in fashion, clothing, and textile production.

This study examines the current state of the global apparel supply chain and projects future trends. We identify the locations of major players, including apparel retailers, apparel suppliers, textile suppliers, raw textile material suppliers, and apparel and textile machinery suppliers. We explore the key factors shaping the future development of the chain and project the dominant trends in the coming years.

At present, the US and China are the world's two largest apparel consumers, while the EU and the US are the two largest apparel importers. Asia dominates global clothing and textile exports, with China, Bangladesh, Vietnam, Turkey, and India ranking among the top 10 global clothing exporters and collectively accounting for nearly half of the world's clothing exports. Six Asian countries—China, India, Turkey, Vietnam, Pakistan, and South Korea—are among the top ten textile exporters, contributing to two-thirds of the world's textile exports.

Raw textile material suppliers are widely distributed across the Americas, Oceania, Asia, and Europe. The top five positions are consistently held by the US, Australia, China, Brazil, and India, with the US being the unshakable leader. Notably, Brazil has shown steady growth in raw textile material exports and rose from its usual fourth place to second in 2024.

In the high-tech apparel and textile machinery segment, China is the leading supplier, accounting for about 35% of global exports. Other major machinery suppliers are developed countries, with Germany, Japan, Italy, and South Korea completing the top five.

Our analysis therefore demonstrates that China is the dominant force in the current global apparel supply chain, leading in three of its four key segments. It is the world's top exporter of clothing, textiles, and apparel and textile machinery, and ranks fourth in raw textile material exports. Additionally, China is a major apparel consumer market, although it remains largely self-sufficient thanks to its extensive production capacity. This dominant position is supported by its well-developed infrastructure, skilled labour force, and vertically integrated supply chain, which continue to make the country a critical player despite increasing global diversification efforts.

The apparel supply chain is largely cost-driven, with production costs playing a crucial role in determining manufacturing locations. Today, the industry faces mounting challenges from an increasingly uncertain environment. This report identifies several key forces shaping apparel supply chains: recurring shocks such as regional conflicts and pandemics are prompting a shift towards 'just in case' supply chain strategies, while escalating great power competition —particularly between China and the US—is driving further diversification away from China. Affordable and efficient labour continues to sustain developing Asia as a leading manufacturing centre, while technological breakthroughs in artificial intelligence (AI), 3D printing, robotics, biomaterials, and digitalization are revolutionizing the industry and its global supply chains. Rising trade protectionism is counterbalanced by regional free trade agreements such as the Regional Comprehensive Economic Partnership (RCEP), which fosters integration and optimization of Asian apparel supply chains, especially between China and ASEAN member states. Domestic regulations and policies in sourcing countries are strengthening the competitiveness and export performance of their apparel industries. Last but not least, sustainability remains a prominent global concern, drawing increasing attention from apparel consumers and lawmakers, pressing all apparel practitioners to put ESG considerations on their agenda.

In the coming year, we anticipate that a more complex sourcing environment and worsening global geopolitical conditions will compel an increasing number of apparel companies and apparel retailers to adopt a sourcing diversification strategy. Such a strategy will balance cost, quality, product lead times and compliance, while also allowing for quick adaptation to market uncertainties and achieving supply chain flexibility and resilience. Our analysis shows that China's export share has only decreased in the final segment of the apparel supply chain—apparel manufacturing—dropping from a peak of 40% in 2013 to the current 30%. Meanwhile, its exports share in each of the other three segments—textiles, raw materials, and machinery—has increased. In apparel manufacturing, Poland, Mexico, and Pakistan recorded the highest share increases in export share from 2018 to 2023, but none surpassed 2.5% of the global total as of 2023. Bangladesh and Vietnam, the top apparel exporters in

Asia, saw their export shares increase over the ten-year period from 2013 to 2023, yet both experienced a decline from 2018 to 2023, indicating a recent slowdown in the shift of apparel production to Asian countries. This evidence suggests that while diversification is underway, the process will be gradual and prolonged. In the near future, China will remain a pivotal player in the apparel supply chain, and will evolve from a direct apparel exporter to the US and EU markets to become a key provider of intermediate components and a major investor in other apparel manufacturing bases. At the same time, Southeast and South Asian economies are becoming increasingly important as apparel sourcing bases.

Our analysis also shows that, despite extensive media coverage, onshoring and nearshoring in the apparel supply chain are advancing more slowly than anticipated. While nearshore apparel production bases for the US market, including Mexico and CAFTA-DR countries, are progressing well, they face potential setbacks due to erratic and indiscriminate tariff policies implemented by the current US administration. For the European apparel market—defined here as Europe-5, comprising France, Germany, Italy, Spain, and the UK—we find a diverse sourcing strategy that includes onshore (Western and Southern European countries), nearshore, and other global locations, with Asian countries, particularly China, serving as the dominant suppliers across all four segments of Europe-5's apparel supply chain. Onshore sources remain important, while Turkey continues to be the largest nearshore supplier due to its geographic proximity and regulatory alignment. However, Turkey's share in Europe-5's textile and clothing imports has stagnated in recent years, primarily due to its unstable domestic economy. Poland, Austria, Czechia, and Morocco also rank among Europe-5's top nearshore suppliers, but their market shares remain too small to gain significance.

New technologies will continue to play a crucial role in shaping the future of the apparel industry, with AI, manufacturing automation, and innovative fabrics as the key drivers. The potential for widespread AI application in the apparel supply chain became more evident in 2025, driven by significant advancements in generative AI, which enables seamless integration into operations, convincing managers that AI has matured enough to enhance productivity and profitability. Industry experts highlight that the rapid development and maturation of AI technologies are also creating a growing urgency across the sector to adopt AI solutions quickly.

Both developed and developing countries recognize the importance of automating textile and apparel manufacturing to maintain competitiveness and ensure high-quality production in an evolving market. Therefore, automated machinery will increasingly replace manual processes in textile and apparel manufacturing in the coming years. Rapid advancements in Chinese textile machinery, combined with global investments by Chinese apparel firms, further facilitate automation adoption.

Growing consumer demand for sustainable, high-performance, and athleisure apparel has driven explosive innovations in functional fabrics. Advanced materials such as moisture-wicking, thermal, and smart fabrics embedded with health-monitoring sensors, alongside eco-friendly options like recycled textiles and biodegradable fibres, enhance apparel performance while reducing environmental impact and reliance on traditional raw materials. Innovative dyeing technologies further support sustainability by substantially reducing water usage. Despite high costs and slow industry adoption, significant investments since the 2020s suggest that breakthroughs in next-generation materials may soon reshape apparel sourcing and production.

Despite ongoing geopolitical and economic challenges, global commitment to ESG principles remains strong and steadily shifts towards more practical and action-oriented approaches. The EU continues to lead in formalizing, regulating, and operationalizing ESG, through initiatives such as its newly unveiled Digital Product Passport, which exemplifies a pragmatic step towards simplifying and optimizing ESG compliance across the entire supply chain. China, as a dominant player, is assuming greater responsibilities in ESG efforts. The Chinese apparel sector has been moving aggressively towards the country's 'dual carbon' goals—peaking carbon dioxide emissions by 2030 and achieving carbon neutrality by 2060—by substantially reducing their domestic carbon footprint while forging partnerships with key apparel manufacturing countries in Asia and Africa to promote sustainability, fair labour practices, and gender equality throughout the global apparel supply chain.

We hope this analysis encourages apparel industry players to embrace diversified sourcing, technological innovations, and ESG principles to create a resilient, intelligent, and sustainable global supply chain capable of adapting to an unpredictable world.

# The Evolving Landscape of Global Medical Devices: Supply Chain Resilience and Innovation

## Executive Summary

The global medical device industry is undergoing significant transformation. Factors driving this change include demographic shifts such as the aging population, the rise of non-communicable diseases linked to lifestyle changes, increasing healthcare expenditures, rapid technological advancements, and government initiatives to promote digital medical services and healthcare infrastructure development. Manufacturers are prioritizing R&D investments and medical technology innovation to address emerging health challenges, while simultaneously focusing on collaboration to build more resilient supply chains capable of withstanding future disruptions.

In 2024, the global medical device market generated US$508.3 billion in revenue and is projected to expand to US$717.4 billion in 2030, representing a compound annual growth rate (CAGR) of 5.9%. The US remains the world largest medical device market, followed by China, Germany, and Japan. However, emerging markets are demonstrating higher growth rates than mature economies, with Asia's medical device market expected to achieve a CAGR of 7% through 2030. This faster growth in emerging markets is driven primarily by government healthcare reforms, expanded insurance coverage, and strategic investments in domestic manufacturing capabilities.

With sustained investment and government support, Chinese medical device manufacturers have been advancing up the value chain, competing not only in the budget and mid-tier segments but also increasingly in domestic and global high-end medical device markets. Leading Chinese medical device companies are actively expanding their international presence through multiple strategies, including cross-border M&A, forming strategic alliances with global partners, establishing overseas sales networks, and setting up production facilities and R&D centers in key markets. Additionally, Chinese manufacturers are proactively mitigating risks associated with tariff threats, currency fluctuations, and inflation by diversifying their supply chains and exploring alternative production locations.

To enhance medical infrastructure and attract investment in India, the Indian government announced plans for establishing multiple medical device parks. Moreover, traditional Indian conglomerates from sectors such as automotive, electronics, and textiles have increasingly

diversified into medical device manufacturing, leveraging their existing technological expertise and resources to fulfil growing domestic and global healthcare demand. These strategic moves, combined with government initiatives like the *Production Linked Incentive* (PLI) scheme and the National Medical Devices Policy 2023, have significantly enhanced India's R&D and production capabilities, positioning the country as an emerging global hub for medical device manufacturing and innovation.

Furthermore, the Southeast Asian medical device market is experiencing a significant growth in demand, with strong regulatory support for promoting medical tourism and attracting investment from global device manufacturers. Although these countries are net importers of medical devices, an increasing number of startups are tapping into the market and investing in R&D for cutting-edge medical devices.

Apart from supply chain disruptions brought by the COVID-19 pandemic, medical device companies have had to reassess their sourcing strategies to mitigate geopolitical risks. The US President Trump's global tariff policy in 2025 further increases supply chain uncertainties. Large device manufacturers that started reshuffling their global sourcing strategies due to the COVID-19 disruption have now adopted diversification and localization strategies to enhance supply chain resilience and mitigate uncertainties from potential tariff threats. Some have established a 'twin factory system', allowing products 'made in China' for the Chinese market and products 'made in the US/ Europe' for western markets. Others have extended their manufacturing networks from the US, Europe, and China to other countries, such as Malaysia, Vietnam, and Thailand in Asia; and Mexico, Costa Rica, the Dominican Republic, and Puerto Rico in the Americas. These nearshoring production bases in the Americas play an important role in the US medical device market, driven by geographic proximity, competitive costs, and favourable trade agreements—particularly the USMCA and the CAFTA-DR.

Global medical device makers are cautiously managing their operating and financial strategies amid rising cost pressures. Several factors are driving up total costs, including labour shortages, supply chain complexity, inflation, tariffs, and surges in raw material prices. To mitigate these cost impacts, large medical device manufacturers are reviewing their sourcing plans and operational processes. Common cost-saving strategies adopted by medical device companies include divestiture of low-return businesses, rationalizing product portfolios, renegotiating with vendors, and streamlining business processes. Moreover, global medical device companies are continuously pursuing M&A strategies to diversify operating risks and drive growth. M&A also provides a strategic pathway for acquirers to

access AI-driven medical technologies and innovative solutions from target companies and expand into new markets through acquired entities.

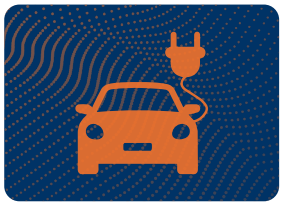
Technological advancements in AI, robotics, and remote healthcare devices are profoundly reshaping medical device makers' location strategies globally. Advanced medical device makers prioritize factory locations with strong access to engineering talent, proximity to world-class universities, and collaboration opportunities with regulatory and clinical partners—factors that ensure rapid product development, efficient iteration, and ongoing improvement after launch.

AI-powered medical devices support diagnostics analysis, reduce administrative burdens, and boost healthcare productivity. However, AI hallucinations, medical errors, and data misuse pose significant risks to patient safety. It is crucial for regulatory bodies to establish clear frameworks and guidelines for AI governance in the healthcare sector and ensure the supply chain stakeholders comply with these requirements.

So far, the medical device industry is undergoing a significant transformation, requiring robust collaboration among governments, regulators, medical professionals, technology developers, and device manufacturers. Device makers must comply with stringent medical device regulatory requirements as well as environmental sustainability standards and data privacy regulations. At the same time, manufacturers should seize opportunities from government support programs to further develop medical device supply chains and enhance innovation capabilities.

The sector must increasingly align with environmental, social, and governance (ESG) imperatives across multiple dimensions, including carbon emissions reduction, waste management, healthcare accessibility, workforce diversity, product safety, and regulatory governance. Advancement in medical technology, including AI-powered equipment and telemedicine, are expected to help medical device companies achieve sustainability objectives and meet ESG goals. By embracing technological innovation, fortifying supply chains, and prioritizing patient-centric values, the global medical device sector is poised to set new benchmarks in healthcare delivery and environmental responsibility.

## Our Global Supply Chain Analysis by Industry



# Electric Vehicle

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# Apparel

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# Medical Device

The Evolving Landscape of Global Medical Devices:
Supply Chain Resilience and Innovation

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