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The Road to a New European Automotive Strategy: Trade and Industrial Policy Options

Navigating the Trilemma of Decarbonization, Competitiveness, and Economic Security

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Table of contents

Acknowledgements P. 4

Executive summary P. 6

List of Figures and Tables P. 8

List of abbreviations P. 9

I . Introduction P. 11

II . Automotive supply chains at a crossroads: the state of play P. 16

III . Decarbonization P. 27

VI . Competitiveness P. 37

V . Economic security P. 46

VI . Policy Options P. 55

1. Regulatory Measures P. 58
2. Trade Policy Instruments P. 62
3. Industrial Policy Measures P. 67
4. Infrastructure Measures P. 75

VII . Scenarios P. 77

VIII . Conclusion P. 82

IX . About the authors P. 84

References P. 85

Executive summary

The European automotive industry stands at a crossroads, facing three concurrent challenges: decarbonizing to tackle climate change, maintaining global competitiveness in a fierce market, and safeguarding economic security amid rising geopolitical tensions. At the heart of the European economy, the automotive sector directly employs 1.4 million people and supports 13 million jobs indirectly across the EU, with implications extending far beyond the industry itself. The transition from internal combustion engine vehicles (ICEs) to electric vehicles (EVs) presents profound challenges, as structural adjustments to production processes and supply chains will significantly affect European employment and economic prospects.[1]

The EU has established a legislative framework for transport sector decarbonization, and the automotive industry has invested substantially in this transition. However, evolving market conditions have created a trilemma of competing objectives: decarbonization, competitiveness, and economic security. Successfully navigating this transition requires a unified yet adaptable European strategy that addresses trade-offs between the objectives, balances short-term priorities with medium- and long-term investments, and coordinates action between private and public sectors.

Each aspect of the trilemma presents both opportunities and challenges for the automotive sector, its supply chain, and the broader European economy. Addressing these issues comprehensively will require coordinated international trade and industrial policies.

The EU aims to achieve 100% zero-emission mobility for all new vehicles by 2035, in line with its commitment to climate neutrality by 2050. This target requires substantial investment in EV infrastructure, battery production, and consumer incentives. However, EV adoption rates vary significantly across member states, creating an uneven transition.

Key challenges include high costs and consumer hesitancy. EVs remain significantly more expensive than comparable ICEs, limiting widespread adoption. Inadequate charging infrastructure and high electricity prices create additional barriers. Europe must also scale up battery production to compete with China's dominance of the global battery supply chain.

The EU automotive industry faces three major challenges to its competitiveness: high production costs, innovation gaps, and significant regulatory burdens. Labor and energy costs in Europe are substantially higher than in China, making it difficult for European manufacturers to compete on price. The transition to electric mobility strains supply chains, particularly for small and medium-sized enterprises (SMEs) dependent on internal combustion engine technologies. Moreover, strict regulatory decarbonization targets must be accompanied by corresponding support measures to avoid overburdening the industry.

External challenges include fierce competition from China and protectionist policies in the United States. China's dominance in EV and battery production, supported by strategic subsidies and economies of scale, poses a formidable challenge to European competitiveness. The US Inflation Reduction Act diverts investments from Europe, while tax cuts planned by the new US administration may intensify competitive pressures.

Rising geopolitical tensions threaten European automotive supply chain stability, particularly

1 The acronym "ICE" is used in this report for internal combustion engine vehicles.

through potential US tariff increases that could cause trade diversion and supply disruptions. The EU's reliance on China's consumer market, raw materials, and battery components creates vulnerability to economic coercion and supply disruptions. While efforts to build resilience through export market diversification, production localization, and domestic capacity scaling are underway, Europe continues to lag in mining, refining, and processing capabilities for critical raw materials.

The integration of digital technologies in modern cars and EV charging infrastructure creates new vulnerabilities, including cybersecurity risks and potential foreign government data collection. The decarbonization process also threatens social and political stability through potential job losses across the ICE supply chain.

This report examines policy measures to support the industry's transition while aligning with EU objectives, providing a toolbox for balancing the strategic triangle outlined in the analytical section. Drawing on more than 70 interviews and stakeholder events, the policy options are organized across four key areas: regulatory measures, trade policy instruments, industrial incentives, and infrastructure investments.

Regulatory measures address coherence across the EU, revision of decarbonization targets, introduction of regulatory incentives for EV adoption, launch of public awareness campaigns, and fair access to in-vehicle data.

Trade policy instruments include notably negotiating new trade agreements, accelerating the adoption of critical raw material agreements, deepening cooperation with Japan and South Korea on battery supply chains, and implementing trade remedies and enforcement actions.

Industrial policy measures include consumer subsidies, support for corporate fleet decarbonization, phase-out of fossil fuel subsidies, increased research and development (R&D) funding, direct subsidies to help SMEs navigate industry changes, and workforce transition assistance.

Infrastructure measures focus on improving charging infrastructure and electricity grids, increasing battery material recycling, and developing hydrogen refueling infrastructure.

This report outlines four potential scenarios based on the interplay between global tensions and international cooperation, ranging from intense conflict and isolation to low tensions and robust collaboration. These scenarios highlight critical factors influencing the automotive industry's future: government support, technological advances, supply chain resilience, and consumer demand.

Actual trajectories will likely combine elements from multiple scenarios, shaped by political and economic developments – particularly decisions made by the new US administration. The EU must navigate these challenges to ensure its automotive industry remains competitive, resilient, and sustainable.

The transition to electric mobility presents a critical opportunity for the EU to achieve its climate goals and maintain industrial leadership. With a narrow window of opportunity, the EU must act decisively to create a competitive and sustainable automotive ecosystem that can rival its global competitors. Active pursuit of market access opportunities will enable European automotive firms to benefit from growing global demand for sustainable mobility. A clear roadmap will facilitate investments required for the transition, particularly from manufacturers. Without decisive action, the EU risks both industrial decline and loss of technological edge in a sector that will define the future of mobility. A holistic strategy combining regulatory, trade, industrial, and infrastructure measures is essential to bridge the innovation gap and ensure the long-term competitiveness of the European automotive industry. The policy options identified in this report, grounded in extensive stakeholder consultations across the EU automotive industry, can also inform the EU's Strategic Dialogue on the Future of the European Automotive Industry. The time to act and future-proof the European automotive industry is now.

List of Figures and Tables

Figure 1: Automotive production landscape in Europe P.12

Figure 2: The trilemma of Europe's automotive industry P.13

Figure 3: Global car sales recovered to pre-Covid levels, with EV sales picking up in China and the EU P.17

Figure 4: China's foreign expansion accelerates in both EV and ICE sales, albeit from low levels P.19

Figure 5: The sales strategies of European firms diverge, especially for the Chinese market P.21

Figure 6: As ICE production remains close to demand, lower production shares partly reflect weakened demand P.24

Figure 7: While EV production is largely localized in Europe, China is growing into an exporter platform for EU firms P.25

Figure 8: 2025 Manufacturer CO_2 targets versus 2023 fleet performance P.29

Figure 9: EV charging points are highly concentrated in the EU P.32

Figure 10: European OEMs remain profitable, both in absolute and relative terms P.44

Figure 11: Suppliers have low profit margins and may be most affected by the transition P.45

Figure 12: Significant local production hides the dominance of Chinese industrial capacity in global EV value chains P.48

Figure 13: China's dominance in global EV supply chains is projected to continue in the mid-term P.50

Figure 14: China's dominance in the upstream sectors of the EV supply chain P.51

Table 1: Distance between key components and vehicle assembly in km P.23

List of abbreviations

AAV:	Autonomous and automated vehicle
ACEA:	Association des Constructeurs Européens d'Automobiles
AFIR:	Alternative Fuels Infrastructure Regulation
ARCADE:	Aligning Research & Innovation for Connected and Automated Driving in Europe
BEV:	Battery electric vehicle
CBU:	Completely built unit
CEF:	Connecting Europe Facility
CKD:	Completely knocked down
CRM:	Critical raw materials
ESG:	Environmental, social, and governance
ETS:	Emissions Trading System
EV:	Electric vehicle
FDI:	Foreign direct investment
FTA:	Free trade agreement
GATT:	General Agreement on Tariffs and Trade
GDPR:	General Data Protection Regulation
ICE:	Internal combustion engine
IEA:	International Energy Agency
IPCEI:	Important Projects of Common European Interest
IRA:	Inflation Reduction Act
LCE:	Lithium carbonate equivalent
LCR:	Local content requirement
LFP:	Lithium iron phosphate
LMFP:	Lithium manganese iron phosphate
MSP:	Minerals Security Partnership
NAFTA:	North American Free Trade Agreement
NMC:	Nickel manganese cobalt

NEV: New energy vehicle

NGO: Non-governmental organization

NZIA: Net Zero Industry Act

OECD: Organisation for Economic Co-operation and Development

OEM: Original Equipment Manufacturer

PHEV: Plug-in hybrid electric vehicle

REACH: Registration, Evaluation, Authorisation and Restriction of Chemicals

SCF: Social Climate Fund

SCM: Subsidies and Countervailing Measures

SME: Small and medium-sized enterprises

SSB: Solid-state battery

USMCA: United States-Mexico-Canada Agreement

V2G: Vehicle-to-grid

VCS: Vehicle connectivity system

VER: Voluntary export restraints

WTO: World Trade Organization

ZEV: Zero-emission vehicle

I. Introduction

The automotive industry is undergoing a historic transformation, driven by the imperatives of addressing climate change, alongside the influences of digitalization and shifting geopolitical currents. This sector lies at the heart of the European economy across member states (Figure 1), accounting for 13 million jobs, or 7% of total EU employment, with 2.4 million people employed in manufacturing.[2] The automotive sector, including OEMs and suppliers, has contributed substantially to EU R&D investment, representing 16% in 2012 and 14% in 2022.[3] This level of investment underscores the sector's strategic importance, and its transition has implications extending well beyond the automotive industry.

Achieving a fully decarbonized automotive sector is an enormous undertaking, made more challenging by China's decade-long head start in EV technology and the complex EU-China relationship. Through early policy support for automotive electrification, China has become a global leader with an integrated supply chain and the world's largest EV market.

For the European Union, this competitive environment poses significant challenges. These may intensify if Donald Trump's campaign promises to fundamentally change the global trading system become reality, particularly given that North American sales are crucial to the European automotive sector. The EU thus faces the complex task of catching up with Chinese battery technology while increasing domestic EV adoption and managing volatile foreign markets for both supply and sales.

Adding to these challenges, Europe's automotive industry remains heavily invested in internal combustion technology – an area where it has led globally but which is becoming a legacy issue. This industrial transformation carries significant social implications, as structural adjustments to production processes and supply chains will profoundly affect employment and regional economies across Europe.

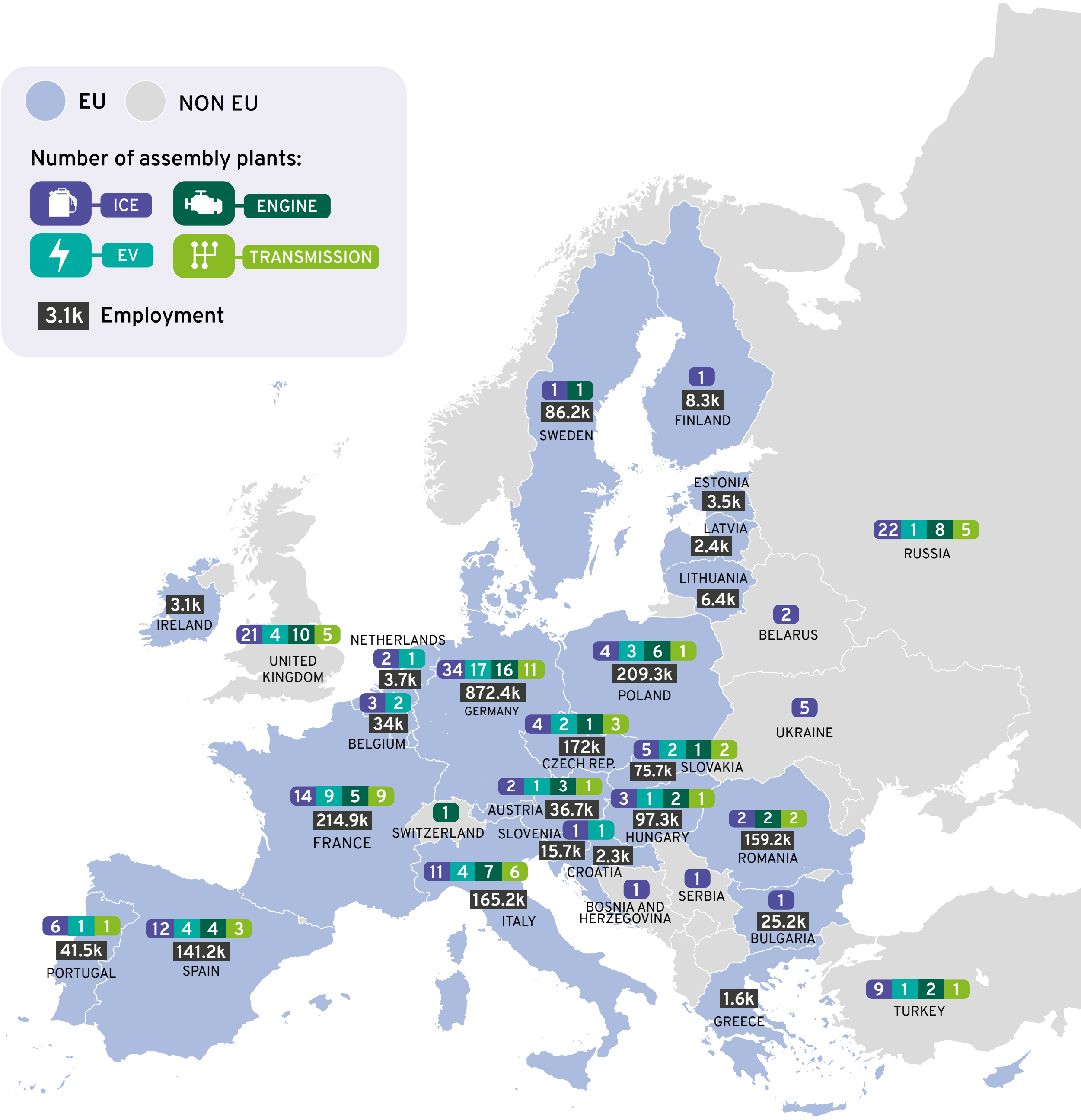
Moreover, recent downturns in the European EV market have generated substantial near-term pressures across the entire value chain. This slowdown stems not only from the unfair trade practices of non-EU competitors but also from shifting consumer demand patterns and the mounting pressures of rapid decarbonization.

2 ACEA, 2024, Pocket Guide 2024/2025

3 European Commission. (2023). *EU Industrial R&D Investment Scoreboard*

FIGURE 1: Automotive production landscape in Europe

Number of plants and direct employment in European automotive manufacturing.



▲ Employment: direct automotive manufacturing employment in 2022 from Eurostat.
Number of plants: author's calculations based on IHS Markit in 2019 (engines & transmission) and 2023 (vehicle assemblies).

The EU's political economy adds another layer of complexity to this transition. Although the automotive industry is broadly distributed across Europe, as illustrated in Figure 1, the diverse interests of the 27 member states – each with its own industrial base and technological capacities – create challenges for finding consensus on a unified European strategy.

Similarly, automotive firms – from small suppliers to large manufacturers – vary in their technological focus, global footprint, and corporate strategies. These differences require an EU strategy that is both flexible and adaptable, recognizing the diverse realities across Europe's automotive sector.

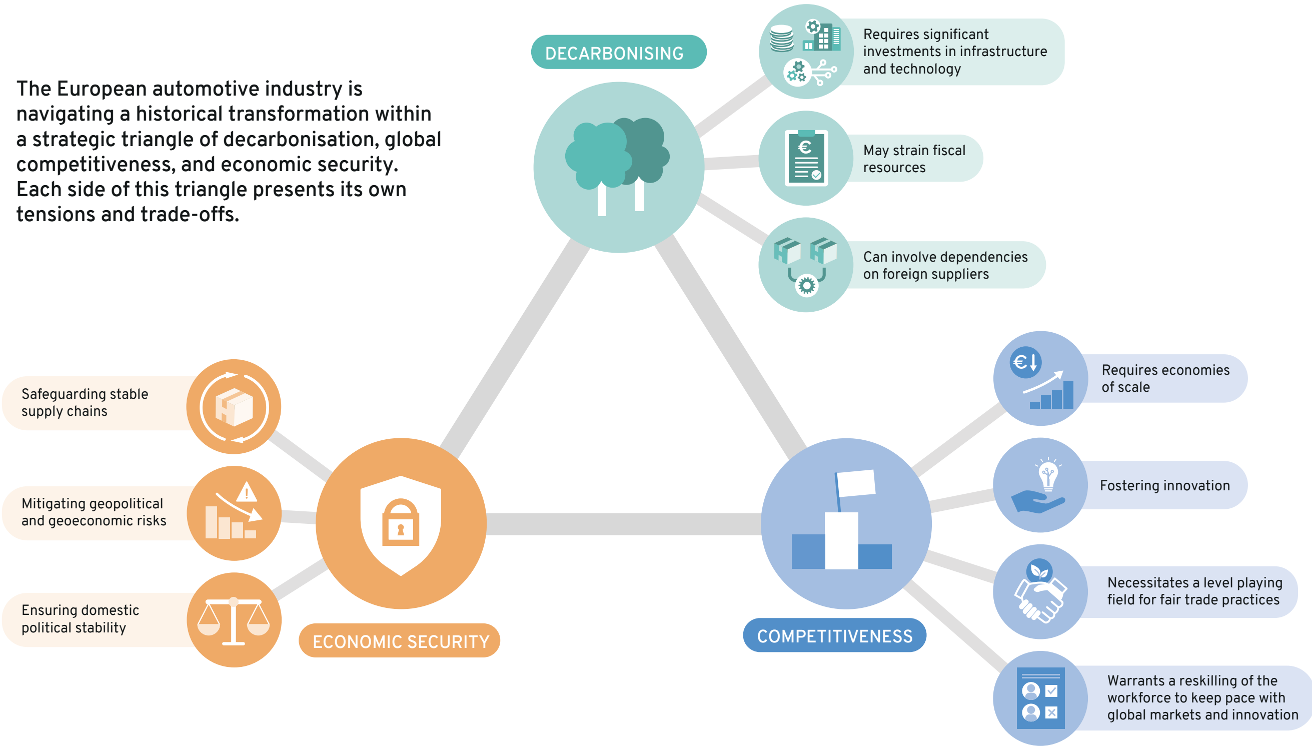
The EU's Common Commercial Policy provides a powerful lever for a joint approach to trade and investment. Open, rules-based market access abroad remains a key concern, as European automotive firms rely heavily on foreign markets for revenue generation, competitive positioning, and technological advancement. Strengthening trade relations will be essential to support Europe's transition to electric mobility while safeguarding industry's long-term viability and global influence.

To address the heterogeneity of the sector, trade and investment policies must be embedded within a broader strategy for the automotive industry that encompasses regulatory, industrial policy, and infrastructure measures. Decision-makers must develop a holistic approach to address multiple objectives simultaneously. A proactive strategy, rather than reactive measures, will be essential for addressing the fundamental challenges faced during this transition.

This report examines the European automotive sector's challenges and policy needs through the lens of a strategic triangle – or trilemma – comprising three interlinked objectives: decarbonization, competitiveness, and economic security (Figure 2). Each side of the triangle represents a critical EU policy goal, but pursuing these objectives involves complex trade-offs that must be carefully managed.

For example, decarbonization requires significant investments in infrastructure and technology, straining fiscal resources and increasing dependence on foreign suppliers. Ensuring a level playing field to maintain competitiveness may slow the pace of decarbonization. Similarly, efforts to secure stable supply chains for economic security, aimed at mitigating political risks, often lead to higher input costs.

FIGURE 2: The trilemma of Europe's automotive industry: trade-offs between decarbonisation, economic security, and competitiveness objectives



Beyond these objectives, the transformation of the European automotive industry risks creating geographically concentrated unemployment. Any common European strategy must therefore consider social impacts and their political implications.

Analysis of policy options for the European automotive industry – stemming from the EU's objectives of competitiveness, decarbonization, economic security, and employment – raises several key questions:

1. What constraints hinder the shift away from internal combustion engines, and what measures can best address these constraints?
2. How can trade and industrial policy measures help achieve the transformation objectives?
3. What roles do China and the United States play in EU decarbonization efforts? How can rules and regulations strengthen European technological capabilities, protect competitiveness and security objectives, and allow the EU to catch up to the technological frontier without excluding others from the single market?

Answering these questions requires an integrated analysis of the industry's transition and its challenges to inform a comprehensive European strategy.

Such a strategy must carefully consider the timing and sequencing of policy interventions – whether short-, medium-, or long-term – and evaluate their immediate risks, implementation timelines, and potential for maximum impact.

This report addresses these questions through both qualitative and quantitative analysis. Between June and September 2024, the authors conducted over 70 interviews with representatives from across the European automotive sector, such as analysts and executives from OEMs, automotive suppliers of all sizes, including battery manufacturers, non-governmental organizations (NGOs), industry associations, financial analysts, and experts from international organizations. Several trade unions were also contacted.

The semi-structured interviews followed a detailed questionnaire developed from preliminary research on European automotive supply chains. These interviews captured a wide range of perspectives on the industry's challenges and opportunities, the competitive landscape with non-European players, and potential policy responses.

Quantitative analysis complements our interview findings. The report comprehensively maps changes in automotive supply chains, tracking shifts in production, sales, and trade flows during the transition to electric vehicles. The next section outlines our data sources and analytical methods.

Initial findings, including a preliminary diagnosis and policy options, were presented through a series of stakeholder events in Geneva, Paris, Strasbourg, and Beijing during October and November 2024. Participants from industry, member state governments, the European Parliament, NGOs, think tanks, and industry associations provided valuable feedback that strengthened the final analysis.

The extensive qualitative and quantitative material collected through this iterative process informed the detailed set of policy options and potential scenarios presented in later sections. Academic literature provides additional evidence for the viability and limitations of these approaches.

The remaining sections of this report analyze the challenges and policy considerations across each dimension of the strategic triangle. They explore critical trends reshaping automotive supply chains, the imperatives of decarbonization, competitiveness pressures from global rivals, and strategies for economic security. A subsequent section on policy options outlines potential pathways to support the industry's transition. The final section presents scenarios to evaluate which policies are best suited to address various plausible futures.

This report does not provide specific recommendations or business strategies for individual companies. Instead, it examines the industry's current state and challenges, presenting a list of policy options, measures, and instruments with their advantages and disadvantages. This analysis aims to help industry, governments, and EU institutions develop coherent strategies and policies.

The Strategic Dialogue on the Future of the European Automotive Industry, announced by European Commission President Ursula von der Leyen in November 2024, provides a timely opportunity to develop a more coherent and forward-looking approach. Drawing from extensive consultations with diverse industry stakeholders, this report offers evidence-based insights and policy options to inform the dialogue process and help forge a common vision for Europe's automotive sector.

As outlined above, the trilemma between decarbonization, competitiveness, and economic security forms the central analytical framework of this report. The following sections examine each dimension individually before integrating them into this framework to highlight key challenges and trade-offs.

II.

Automotive supply chains at a crossroads: the state of play

The shift toward EVs and emergence of new industry players are reshaping global automotive supply chains, creating challenges and opportunities for both established and emerging markets. This section provides an overview of the automotive industry and its prospects, highlighting two major trends: (i) the accelerating transition from internal combustion engines to electric vehicles, and (ii) China's emergence as a global industry leader.

SALES TRENDS: THE TRANSITION TO EVS AND CHINA'S CONSUMER MARKET ASCENDANCE

Global sales figures in 2023 highlight the rapid shift from ICEs to EVs. ICE sales decreased by 11% from 2018 levels to 81 million units, while EV sales rose more than eightfold over the same period, from 1.3 million to 10 million units.

This shift affects market dynamics and geography of production, particularly in the EU, the North American Free Trade Agreement (NAFTA) region, and China.

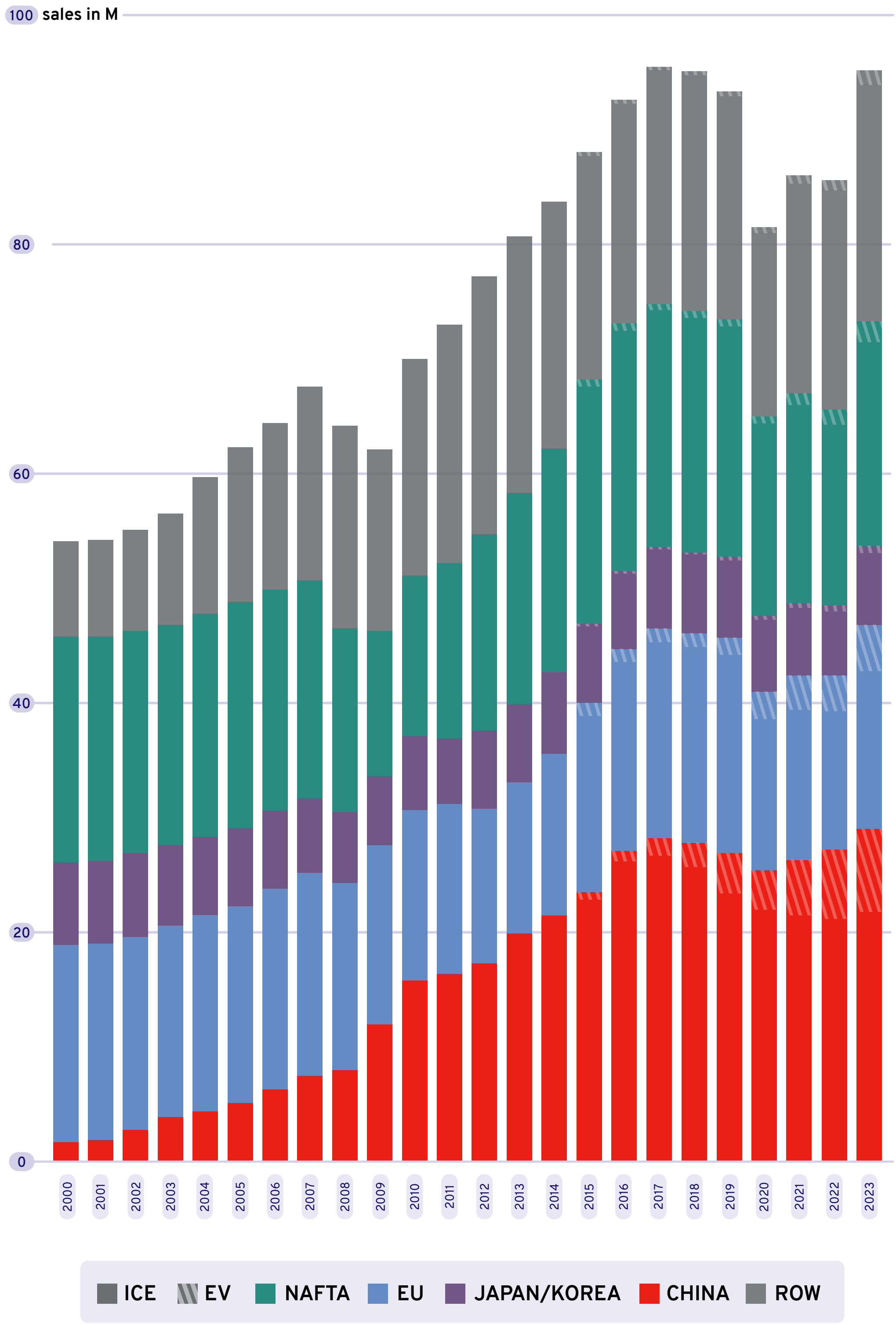
Together, these three markets accounted for approximately two-thirds of global ICE sales and 85% of global EV sales in 2023.

Within the past decade, China has emerged as the dominant consumer market, accounting for 30% of global ICE sales and 53% of global EV sales in 2023. In particular, its EV market expanded from 0.7 million units sold in 2018 to 5.3 million in 2023.

The EU's EV sales growth outpaced China's during this period, showing an eightfold increase, though from a lower base. By 2023, the EU accounted for approximately one-fifth of both global EV and ICE sales.

Internal combustion engines still dominate the NAFTA market. Although EV sales have quadrupled – a less dramatic increase compared to other regions – NAFTA represented only 14% of global EV sales in 2023, compared to 22.5% of global ICE sales (Figure 3).

FIGURE 3: Global car sales recovered to pre-Covid levels, with EV sales picking up in China and the EU
Global passenger car sales by market, in million units.



DATA AND METHODOLOGY

Unless otherwise indicated, the primary data in this report originates from S&P Global. This includes information on sales volumes by origin and destination for all car models. The data provides: (i) details on sales origins, both domestic and imported, enabling the tracking of trade flows at the model level, and (ii) information on the nationality of brands, facilitating the measurement of foreign direct investment. The dataset covers passenger vehicles and light trucks, including pick-up trucks, but excludes heavy trucks.

For EVs, the analysis includes separate data on production at the plant level (origin) for the 2015–2022 period, also sourced from S&P Global. Production figures are converted to sales by origin and destination, matching sales data for each car model and plant combination. For instance, the Nissan Leaf produced in the UK has different destinations than units produced in the US, as shown by the sales data. Here, 'EVs' refers exclusively to battery electric vehicles (BEVs), covering both passenger cars and light trucks.

Firms are classified based on majority ownership at the group level as of 2023, with brand headquarters determined by the location of the parent company. For example, Volvo, owned by Geely, is classified as a Chinese brand, and Chrysler as Dutch through Stellantis's ownership of Fiat Chrysler Automobiles and PSA, even prior to their merger.

The classification of the EU region refers to the 27 current member states, excluding the United Kingdom, even before Brexit.

Other sources are indicated for each figure where applicable.

DEMAND TRENDS: REGIONAL PREFERENCE PERSISTS AMID CHINA'S GROWING INFLUENCE IN EV MARKETS

In North America, ICEs continue to dominate the market. Japanese and South Korean automakers, following their successful market entry in the 1980s, lead local sales, closely followed by NAFTA-based brands. Over the past decade, these manufacturers have maintained the majority market share, while European automakers have consistently held approximately 20%. Chinese brands, which entered the market in 2018, maintain a limited presence – less than 1% for ICE and 1.3% for EVs. In the EV segment, consumer preference for domestic brands is more prominent, mainly driven by Tesla's market leadership. As production typically aligns with local demand, these sales patterns influence global production and foreign direct investment, as detailed later in this report.

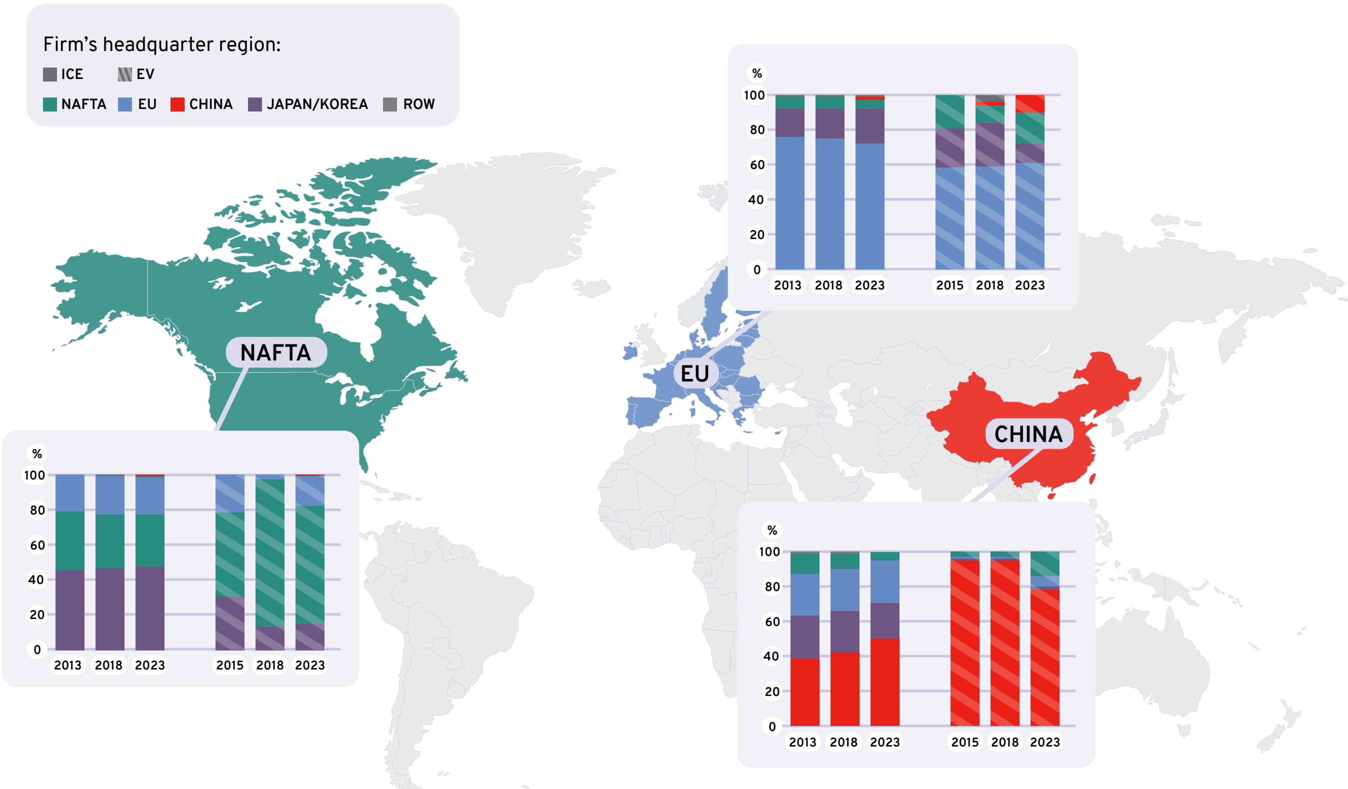
Europe presents a different landscape. EU-based automakers historically dominate the ICE market with approximately 75% share. Foreign brands, primarily from South Korea and Japan, account for the remaining 25%, with Chinese manufacturers holding only 1.7% of the ICE market in 2023 despite posting the strongest growth rates.

The EV market shows different dynamics. Stringent emissions regulations and sustainable mobility initiatives have accelerated EV adoption compared with NAFTA. Chinese firms have gained significant market share, growing from negligible presence in 2018 to 10% in 2023, largely at the expense of Japanese and South Korean brands. This growth reflects China's strategic focus on European EV exports, capitalizing on the region's increasing EV demand. Japanese and South Korean manufacturers have maintained a steady presence in the European market but show slower EV transition than European and Chinese competitors, translating into declining market share in Europe. North American presence remains modest in ICEs but stronger in EVs, driven nearly entirely by Tesla.

China's automotive landscape has transformed dramatically during the last decade while back in 2013, foreign brands from the EU, Japan, and South Korea dominated ICE production. Over the next decade, many new Chinese automotive brands entered the market, collectively capturing more than 10% of ICE sales. Meanwhile, China's aggressive pivot towards EVs resulted in domestic brands holding 95% of the EV market in 2015. However, by 2023, this share decreased as NAFTA and EU manufacturers gained a combined 20% of the EV market.

Figure 4 below shows the market share distribution by firm headquarters region.

FIGURE 4: China's foreign expansion accelerates in both EV and ICE sales, albeit from low levels.
Market shares in main sales markets by firm's headquarter regions.



▲ Source: own calculations by Sophia Praetorius

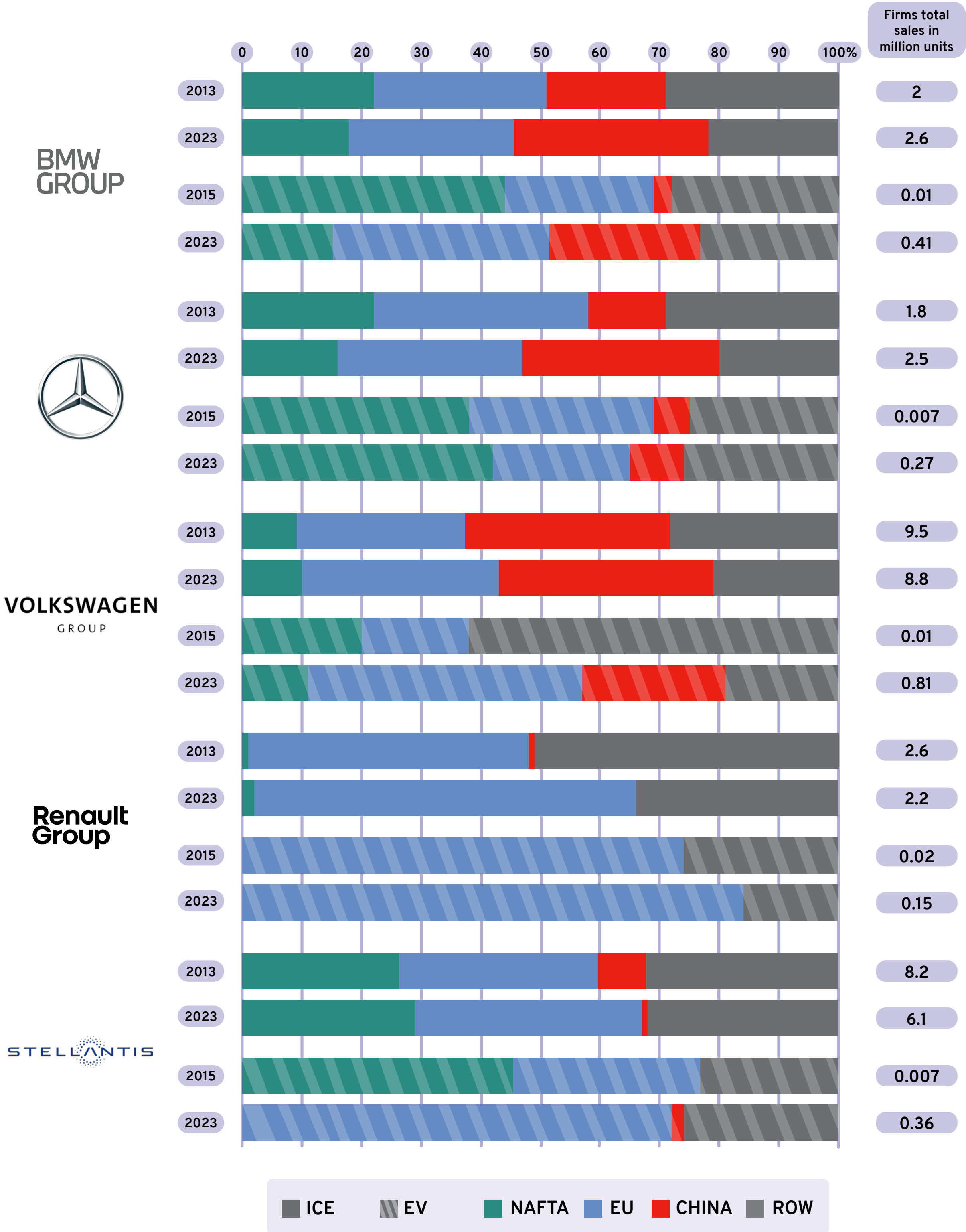
SALES STRATEGIES: DIVERGENT OEM PREFERENCES FOR GLOBAL MARKETS

Firm-level analysis (Figure 5) reveals distinct sales strategies among major EU automakers, though Europe remains their primary market. Renault increased its focus on the EU, with its sales share rising from 50% in 2013 to 68% in 2023. Stellantis showed moderate growth in both the EU market (from 41% to 44%) and the NAFTA market (from 26% to 30%). During this period, both manufacturers retreated from the Chinese ICE market – Stellantis saw its sales share drop from 8% to 1%, while Renault exited the market entirely.

In contrast, German manufacturers adopted more global strategies, as reflected in their sales and production patterns. BMW and Mercedes-Benz reduced their EU sales share (from 39% to 33% and 44% to 35%, respectively) while expanding primarily in China and, to a lesser extent, NAFTA. By 2023, China had become their largest ICE market, with Mercedes-Benz increasing its share by 170% over the decade and BMW by 75%. Volkswagen also shifted its focus towards the EU and China, with sales shares rising by 15% and 8%, respectively, between 2013 and 2023.

The transition from ICEs to EVs is evident in manufacturers' sales figures. BMW, Mercedes-Benz, Volkswagen, and Stellantis achieved an average forty-fold increase in EV sales over the past decade, while Renault – starting from a higher initial level – recorded a 7.5-fold increase. Declining ICE sales for most manufacturers (except Mercedes-Benz and BMW) further underscore this shift. Throughout 2013–2023, the EU remained the primary EV market for all manufacturers except Mercedes-Benz. BMW and Stellantis notably redirected EV sales from NAFTA to China, reflecting both China's growing demand and the relatively stagnant US market, where Tesla's dominance has increased. However, manufacturers' EV sales show less reliance on China compared to their ICE sales.

FIGURE 5: The sales strategies of European firms diverge, especially for the Chinese market



▲ The brands associated with each automotive group are as follows: BMW Group includes BMW, Mini, and Rolls-Royce; Mercedes-Benz Group includes Mercedes-Benz, Mercedes-Maybach, Mercedes-AMG, and Smart; Volkswagen Group includes Volkswagen, Audi, Porsche, SEAT, Škoda, Bentley, Bugatti, and Lamborghini; Renault Group includes Renault, Dacia, and Alpine; and Stellantis includes Abarth, Alfa Romeo, Chrysler, Citroën, Dodge, DS Automobiles, Fiat, Jeep, Lancia, Maserati, Opel, Peugeot, Ram, and Vauxhall.

▲ Source: own calculations by Sophia Praetorius

SUPPLY TRENDS: LOCALIZATION PATTERNS FROM THE ICE INDUSTRY PERSIST FOR EVS

The shift towards EVs and China's rise as a global player are reshaping market dynamics and, more significantly, the geography of production. EV and ICE manufacturers face similar strategic considerations: deciding *where* to produce their vehicles while balancing final market demand, access to key inputs, and trade costs.

ICE production remains regionally concentrated, with most sales occurring within continental markets due to high transport costs and trade barriers. Manufacturers typically establish local production through foreign direct investment once market demand justifies it, thereby avoiding transport costs and tariffs. As a result, 73% of EU, 75% of NAFTA, and 96% of Chinese vehicle sales come from domestic production. The EU's imports from outside the bloc, accounting for 21.4% of sales, largely originate from nearby production sites in the UK, Turkey, Serbia, and Morocco.

Regional production patterns are even more pronounced for EVs. Their larger dimensions and heavier weight, due to batteries, reduce shipping capacity in existing vessels. Additionally, transporting batteries often requires special safety measures, increasing trade costs compared to ICEs.[4] As a result, imported vehicles accounted for only 25% of global EV sales in 2023, compared with 34% for all vehicles. However, this trend is largely driven by China, as regional production varies significantly. Only 65% of EVs sold in the EU are produced domestically, compared with 73% in NAFTA and 99% in China.

An important implication is that rising foreign brand sales shares (discussed in the previous section) typically drive increased local investment, following a pattern established in the 1980s when Japanese and South Korean manufacturers responded to growing demand in Europe and particularly NAFTA. The 1981 Voluntary Export Restraint (VER) agreement between the Reagan administration and Japan accelerated this trend by raising trade costs. While export shares declined, foreign brands expanded their local market shares.[5] Growing EV demand and trade restrictions on Chinese firms suggest these manufacturers may follow a similar path towards localized production.

The ICE and EV production strategies of European firms, illustrated in Figures 6 and 7, reveal distinct global manufacturing patterns. Reflecting the importance of the EU market in their sales strategies, European firms produce approximately 49% of their ICEs within EU borders – a 4% decrease from 2013, partly due to shifting demand towards NAFTA and China, as discussed above. For the EU market, a significant share of production is sourced from neighboring countries such as Morocco and Turkey, which together account for nearly 24%. Notably, production in the NAFTA region has increased by more than 50% since 2013, with 82% of it serving local market demand, driven by larger overall ICE demand in NAFTA.

For EVs, European firms rely more heavily on Chinese imports than for ICEs, with Chinese-made EVs accounting for about 17% of European EV imports. This highlights China's growing role as a global EV export hub. China's share of global EV production rose from zero in 2015 to 20% in 2023, reflecting its rapid emergence as a major player in the EV industry. However, battery production remains highly localized. Like internal combustion engines, battery packs, modules, and cells – representing up to 40% of an average EV's value – are difficult to ship over long distances.[6] Consequently, manufacturers tend to source these critical components close to their assembly plants, concentrating high

4 CEPII. (2024). *Policy Brief 2024–45*. Retrieved from *https://blog.trans-rak.com/how-transport-trends-impact-global-ro-ro-capacity*, Maersk. (2024). 'Shipping Batteries.' Retrieved from *https://www.maersk.com/logistics-explained/transportation-and-freight/2024/04/04/shipping-batteries.*

5 CEPII. (2024). *Policy Brief 2024–45*

6 T&E. (2024). *To raise or not to raise: How Europe can use tariffs as part of an industrial strategy*. Briefing, March 2024, p. 14.

value-added production stages near assembly locations (Table 1).

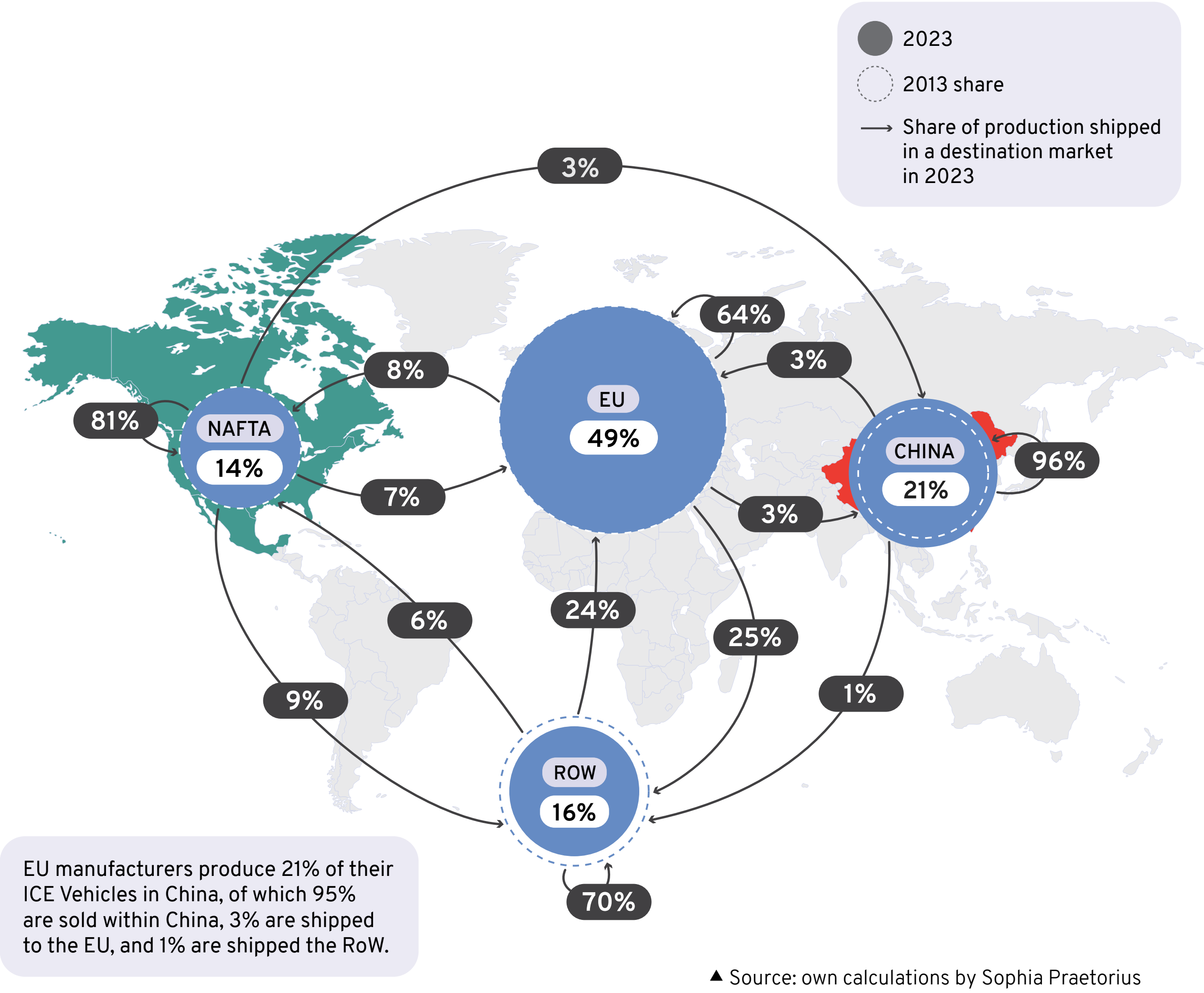
Whether this trend continues depends on the balance between local demand and production costs, including trade, manufacturing, and material costs. This highlights a key distinction between ICE and EV production patterns, particularly in their upstream supply chains for main components. While legacy automakers have mastered integrated powertrain production for ICEs, they lag in EV value chains, especially in the production of their most critical component – the battery. The battery supply chain is geographically concentrated and controlled by a small number of firms, with China hosting 81% of global battery production. This dominance gives China significant comparative advantages across the EV value chain, making it an increasingly attractive location for production. However, current localization patterns and incentives could shift if projected price decreases in Chinese lithium iron phosphate (LFP) batteries materialize.

TABLE 1: Distance between key components and vehicle assembly in kilometers

Link	Year	Distance in km	
		median	mean
Battery Electric Vehicle			
Pack to Assembly	2015	299	819
	2022	215	641
Module to Pack	2015	1	994
	2022	1	830
Cell to Module	2015	13	1782
	2022	1	477
Internal Combustion Engine Vehicle			
Engine to Assembly	2018	133	1034
Transmission to Assembly	2018	681	2184

▲ Source: CEPII Policy Brief 2024–45 and Sophia Praetorius calculations

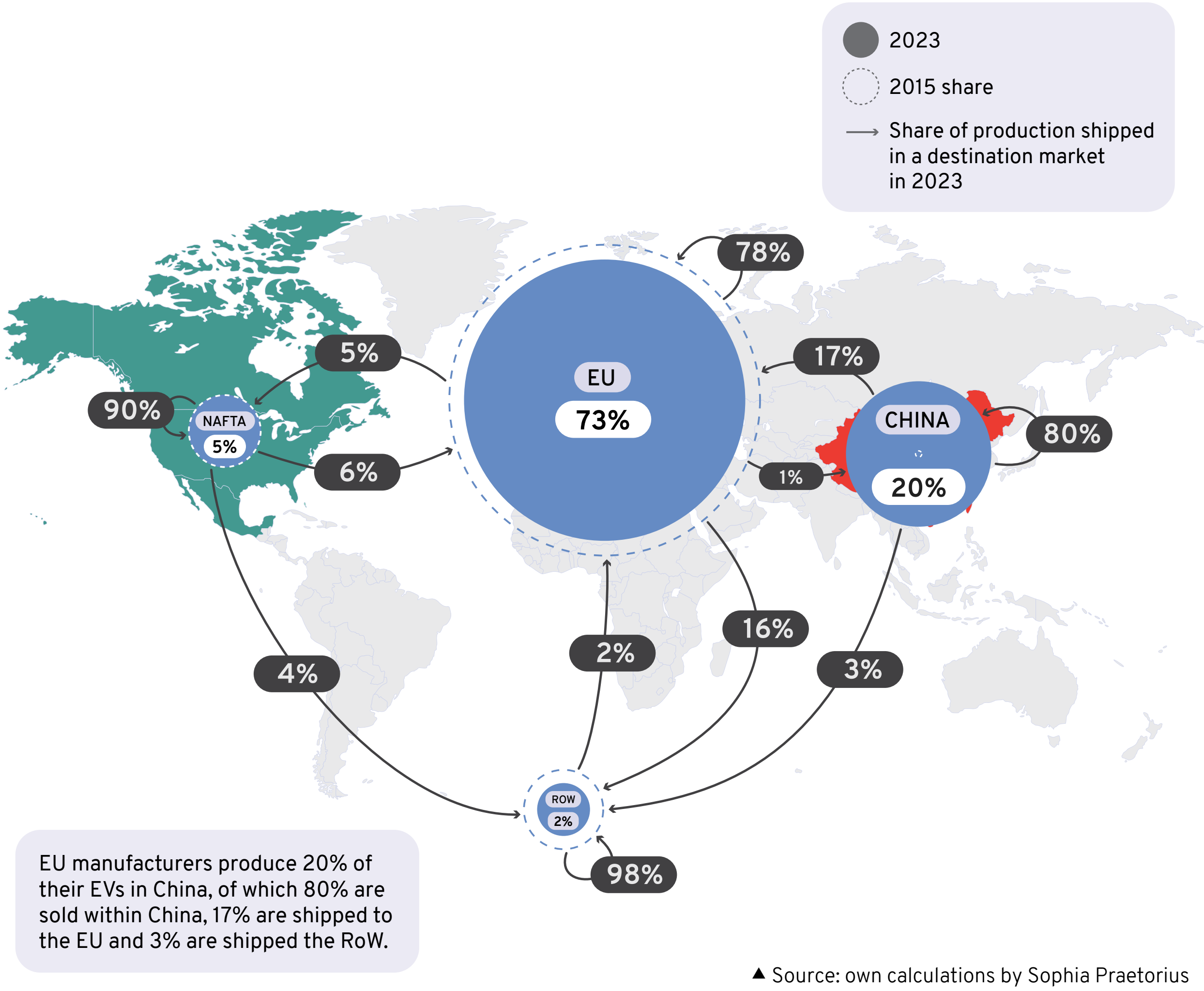
FIGURE 6: As ICE production remains close to demand, lower production shares partly reflect weakened demand
Distribution of the total ICE production of European manufacturers.



▲ Source: own calculations by Sophia Praetorius

FIGURE 7: While EV production is largely localized in Europe, China is growing into an exporter platform for EU firms

Distribution of the total EV production of European manufacturers.



▲ Source: own calculations by Sophia Praetorius

KEY TAKEAWAYS

The global automotive market is shifting decisively from ICEs to EVs. ICE sales were down almost 20% in 2022 from the 2017 peak, while EV sales quadrupled between 2018 and 2023, reflecting a fundamental change in consumer preferences and production patterns.[7] Major markets – the EU, NAFTA, and China – dominate global ICE and EV sales, each following its own distinct trajectory.

NAFTA remains predominantly focused on ICEs, with strong consumer preference for domestic brands and limited penetration of Chinese EVs. Europe emphasizes sustainable mobility, achieving higher EV adoption rates despite increasing competition from Chinese manufacturers, partly driven by China's strategic export growth from a low base. China has undergone the most dramatic transformation, with domestic manufacturers now dominating its EV market through significant increases in production

7 McKerracher, C. (2023). 'Carmakers Can Kiss Pre-Pandemic Combustion Car Sales Goodbye.' *Bloomberg New Energy Finance.*

and consumption. These regional differences reflect the varying priorities within the strategic triangle: the EU leads with sustainability, China focuses on competitiveness, and the United States prioritizes security.

European automakers take contrasting approaches to the Chinese market. Renault and Stellantis have adopted an increasingly localized sales approach, focusing on their home markets. In contrast, German manufacturers pursue a more global strategy, with China serving as a key sales market. On average, 35% of their ICE sales occur in China, with lower but steadily growing EV penetration.

Both ICE and EV markets exhibit strong regional production patterns due to high transport costs and trade barriers. ICE production remains largely local to avoid tariffs, with most sales occurring within the same continent. This regional concentration is even more pronounced for EVs, driven by technical constraints such as battery transport challenges and safety requirements, as well as trade restrictions. While European automakers produce most ICEs within the EU, they increasingly source EVs from China.[8] Morocco and Turkey serve as important production hubs for European-bound vehicles, reinforcing the regional supply network.

8 Note that the data is only available until 2023, thus not capturing the impacts of the countervailing duties by the EU.

III. Decarbonization

The EU's decarbonization goals for the automotive industry stem from its broader commitment to achieve climate neutrality by 2050. As a leading source of global CO_2 emissions, the sector faces stringent targets, including the 2023 decision to phase out sales of ICEs by 2035. This timeline gives automakers a 15-year window – matching the average life cycle of a car – to achieve zero emissions by the middle of the century. The transition presents unique and complex challenges for the automotive sector: transforming deeply integrated global supply chains for internal combustion engines while meeting diverse consumer and manufacturer needs across Europe.

Following the 2015 Dieselgate scandal, the EU automotive industry accelerated its green transformation, aligning with Paris Agreement commitments through multibillion-euro investments in EV production and battery facilities across Europe.[9] However, the EU lags globally. China holds a decade-long head start in EV development, supported by a cohesive industrial policy combining production incentives, extensive charging infrastructure, and market-making initiatives at national, regional, and municipal levels. The United States, meanwhile, benefits from leading technology firms driving advancements in artificial intelligence and autonomous vehicles, potentially placing it further ahead in emerging technologies in the automotive sector. Furthermore, the Inflation Reduction Act offers substantial production-based incentives that draw investment in EV and battery manufacturing, all while operating under more flexible decarbonization rules. This raises the question of how the EU can speed up decarbonization without compromising competitiveness and economic security.

This section examines five key dimensions of the EU's transition to net zero: European CO regulations shaping vehicle supply, the role of corporate fleets and consumer subsidies in driving demand, the critical need for charging infrastructure, the importance of scaling battery production, and the potential of alternative and emerging technologies to reshape Europe's path to decarbonization.

CO_2 REGULATION: DIFFERENT STRATEGIES IN THE AUTOMOTIVE INDUSTRY

The EU's regulatory framework for reducing CO_2 emissions sets a clear trajectory towards zero-emission mobility by 2035 (see Box). However, achieving this milestone requires

9 ACEA. (2024). *Future Driven Manifesto.*

more than just increased EV production. It demands large-scale investments in supporting infrastructure, a stable and secure supply of critical raw materials, and expanded battery production capacity. The transition must also account for the differing capabilities and constraints within the industry, where premium brands often drive innovation while mass-market manufacturers face cost pressures and challenges with consumer affordability.

EU REGULATORY FRAMEWORK FOR REDUCING VEHICLE CO_2 EMISSIONS

In 2021, the EU adopted the 'Fit for 55' package, a regulatory framework designed to reduce net greenhouse gas emissions by at least 55% by 2030 and achieve climate neutrality by 2050. Road transport, accounting for roughly one-quarter of EU carbon emissions in 2020, faces specific CO_2 emission performance standards.

Regulation (EU) 2019/631, amended in 2023, sets the standards for new passenger cars and vans, requiring zero-emission vehicles by 2035. The regulation establishes the following milestones:

- By 2025, new cars must achieve a 15% reduction in average CO_2 emissions from 2021 levels. OEM fleets must meet an average target of 93 g/km (gram per kilometer), equivalent to approximately 4.0 L/100 km (liters per 100 kilometers) in fuel consumption.
- By 2030, new cars must achieve a 37.5% reduction and new vans a 31% reduction. OEM fleets must meet an average target of 49 g/km, equivalent to approximately 2.1 L/100 km in fuel consumption.
- By 2035, all new cars and vans registered in Europe must be zero-emission vehicles.

Manufacturers face penalties of €95 for every g/km of CO_2 exceeding their emission target, multiplied by their total vehicle registrations that year.

The regulation includes a review clause requiring the EU to reassess and potentially adjust the targets in 2026, ensuring alignment with technological advancements and market trends. E-fuel-powered vehicles are classified as zero-emission vehicles under this framework.

Decarbonization progress varies significantly across OEMs. The small car segments lags in particular, and despite massive investments in the transition, most automotive production in the EU remains geared towards internal combustion.[10] Out of 12.1 million cars produced in the EU in 2023, only 2.4 million vehicles were electric.[11]

While some European manufacturers, particularly in the premium segment, are already exceeding decarbonization targets, mass-market brands face greater challenges. Their price-sensitive customers struggle to afford the 10–50% premium for battery EVs.[12] Though European OEMs currently meet 2025 milestone targets, they must further reduce average emissions, which may be challenging given stagnating EV sales in Europe. Failure to meet CO_2 reduction targets could result in billion-euro penalties, which is particularly challenging for manufacturers already struggling to ramp up EV production.

Figure 8 shows that OEMs must, on average, achieve a CO_2 reduction of 12% between 2023 and 2025 to comply with EU emission rules. This target appears modest compared with the 23% reduction achieved between 2019 to 2021,[13] yet historical patterns suggest manufacturers typically wait until mandatory deadlines approach before meeting CO_2 targets.[14]

10 GERPISA. (2024). *European Regulations for an Affordable Sustainable (Battery) Electric Vehicle.*

11 International Energy Agency. (2024). *Energy Technology Perspectives.*

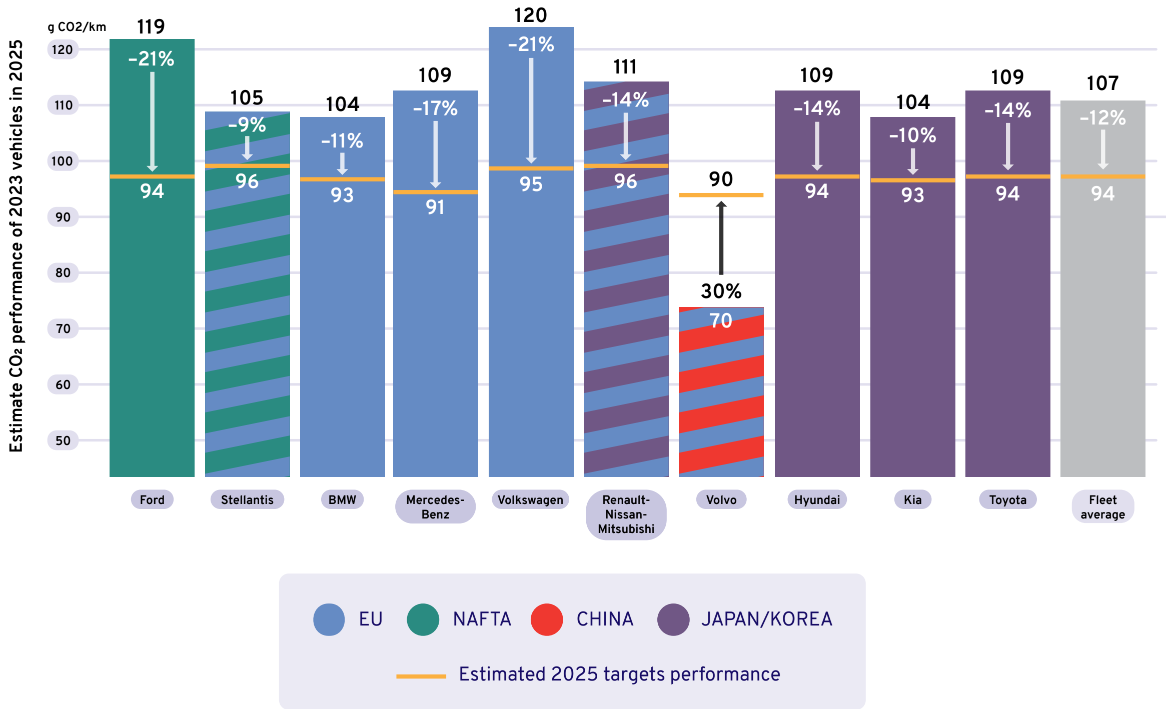
12 International Energy Agency. (2024). *Global EV Outlook 2024*. p. 13.

13 ICCT. (2024). *Within reach: The 2025 CO_2 targets for new passenger cars in the European Union*. p. 9

14 T&E. (2024). *The drive to 2025: Carmakers' progress towards their EU CO_2 target in H1 2024*.

OEMs have several options to comply with CO_2 emissions reduction standards: reducing high-emission vehicle sales to lower fleet averages,[15] adopting mild hybrid technology, or forming emission pooling agreements with low-emission producers, such as new entrants from China or Tesla.[16]

FIGURE 8: 2025 manufacturer CO_2 targets versus 2023 fleet performance



▲ Source: ICCT. (2024). *Within reach: The 2025 CO_2 targets for new passenger cars in the European Union.*

Meanwhile, the divide between premium and mass-market manufacturers continues to widen. According to McKinsey & Company, the premium segment of the automotive industry is projected to show the strongest growth through 2030 while maintaining the highest profit margins.[17] This financial resilience allows premium brands to invest heavily in EV development. In contrast, mass-market manufacturers typically operate with narrower margins, which constrains their ability to invest in new technologies.

Material costs present a particular challenge for small vehicles. According to Boston Consulting Group, B-segment EVs cost approximately 65% more in materials than ICEs, averaging €15,700 for EVs versus €9,400 for an ICE.[18] This cost differential could lead to further restructuring, particularly among smaller OEMs and suppliers dependent on internal combustion engine technology.

15 Pooling under Regulation (EU) 2019/631 allows vehicle manufacturers to jointly meet CO_2 emission targets by averaging their fleet emissions, effectively treating them as a single entity for compliance purposes. This mechanism enables manufacturers with higher emissions to offset them by partnering with those whose fleets emit less.

16 ICCT. (2024). *Within reach: The 2025 CO_2 targets for new passenger cars in the European Union.*

17 McKinsey. (2022). *BEVolution of luxury vehicles: How customer preferences are changing the luxury vehicle market.*

18 BCG. (2023). *The High-Stakes Race to Build Affordable B-Segment EVs in Europe.*

Ahead of the 2026 revision, the EU decarbonization policy has elicited mixed responses from the European automotive industry. Critics highlight its emphasis on penalizing non-compliance rather than facilitating investments in electrification – contrasting with approaches in China and the US.[19] Concerns also exist about emission permit trading, where European automakers could transfer financial resources to Chinese or American competitors instead of investing in domestic innovation and capacity.

These divergent perspectives highlight the challenge of establishing a unified decarbonization strategy for the European automotive industry. Success requires both supply-side commitments and robust demand-side support to transform the entire industry.

MEMBER STATE DIVERGENCE THREATENS DECARBONIZATION PROGRESS

The choices of European consumers are shaped by national policies that differ significantly across member states. For instance, Denmark exemplifies successful BEV adoption, achieving 48% of new car registrations in 2024 through a combination of tax policies, extensive charging infrastructure, and other supportive measures.[20] By contrast, Italy, with comparatively limited incentives and infrastructure development, saw BEVs comprise only 1.6% of new car registrations in the same year. These disparities illustrate the growing divide between fast-moving and lagging markets, with little evidence of convergence since electrification began to take off in Europe.

This persistent market fragmentation, with member states advancing at differing speeds, threatens the EU's broader decarbonization goals. Creating a unified approach to EV adoption requires harmonized national policies and coordinated infrastructure development.

Several factors can boost demand and accelerate decarbonization: expanding corporate electric fleets, providing consumers subsidies, and addressing range anxiety through rapid charging infrastructure deployment.

CORPORATE FLEETS AND TAX INCENTIVES AS DRIVERS OF DEMAND

Corporate fleets are a significant part of the European automotive market and represent a major opportunity for accelerating EV adoption. Fleet customers – including car rental and corporate leasing companies – account for more than 50% of new car registrations in Europe.[21] Tax incentives and subsidies for fleet electrification could both accelerate the transition and familiarize more drivers with EVs.[22]

EV demand remains highly dependent on consumer subsidies due to the substantial price difference between ICEs and EVs. Germany's experience demonstrates market fragility – EV sales fell from 30% in 2022 to 25% in 2023 following subsidy reductions.[23] This decline followed the phasing-out of plug-in hybrid subsidies in early 2023 and the termination of all EV subsidies in December 2023.

Conversely, France's social leasing program, introduced in early 2024 to help low-income households gain access to EVs, demonstrates the impact of targeted support. EV registrations surged by 33% in the first two months of 2024, reaching 45,841 units and 17% market share.[24] Though overwhelming demand forced temporary suspension, and fiscal constraints led France to reduce purchase subsidies by

19 Financial Times. (2024). 'Costs of the green transition loom large for European companies.'
20 European Alternative Fuels Observatory
21 Allianz Research. (2023). *The Chinese challenge to the European automotive industry.*
22 Transport & Environment. (2023). *The corporate cars problem and what the EU can do about it.*
23 International Energy Agency. (2024). *Global EV Outlook*. p.19
24 *Journal de l'Automobile*. (2024). 'Quand l'électrification joue avec le feu.'

one-third in October 2024, the program's initial success highlights the effectiveness of targeted incentives.[25]

These developments contrast with China, where a coordinated set of policies, including subsidies, extensive charging networks, and access restrictions for ICEs, continues to create conditions for a robust domestic EV market. For instance, purchase tax exemptions for new energy vehicles (NEVs) are estimated to have exceeded €40 billion by the end of 2023, and this policy has been extended until 2027.[26]

Scandinavian countries lead Europe's transition to EVs through favorable tax schemes. Norway has become a global frontrunner, with BEVs reaching 94% of new car sales in 2024.[27] This success stems from comprehensive incentives: purchase tax and value-added tax (VAT) exemptions, reduced road taxes, and lower toll charges for EVs.[28] These measures have substantially narrowed the cost gap between EVs and ICEs.

Sweden and Denmark, the EU's leading markets, also use targeted tax policies to drive EV adoption (Figure 9). Sweden, for example, offers lower benefit-in-kind taxation for EVs in the company car segment,[29] while Denmark combines reduced EV registration taxes with increased ICE taxation.[30]

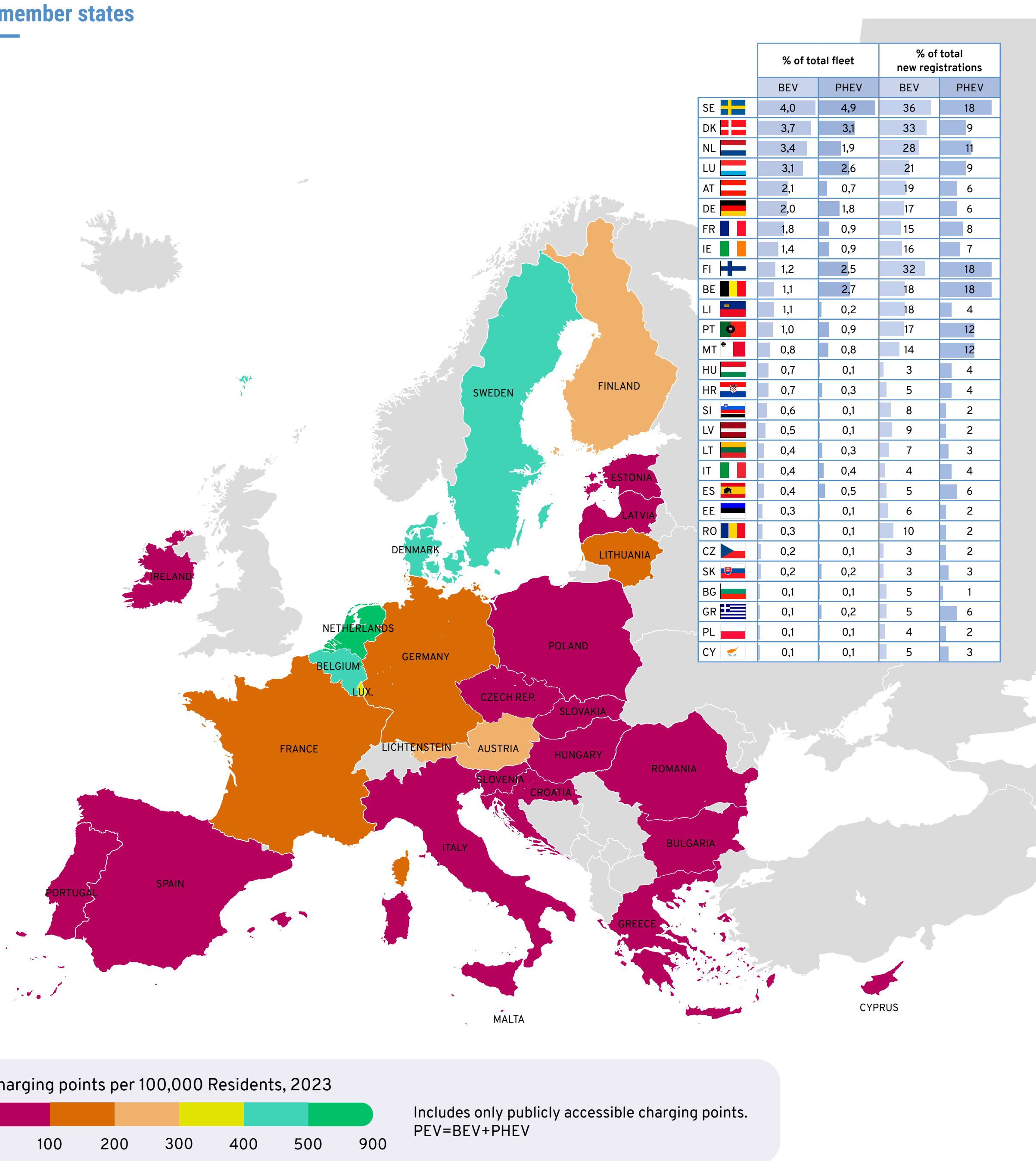
THE ESSENTIAL ROLE OF CHARGING NETWORKS IN THE TRANSITION TO ELECTRIC MOBILITY

The EU's patchy charging network remains a major barrier to EV adoption, as range anxiety and limited charging availability deter consumers.[31] At the same time, manufacturers argue they cannot meet 2035 targets alone. The lack of adequate charging infrastructure places a greater burden on OEMs without corresponding requirements for energy companies and member states. Unlike China's rapid infrastructure expansion, Europe's uneven progress forces manufacturers to install larger, costlier batteries to compensate for the limited charging network, further increasing vehicle prices and slowing adoption.[32]

Figure 9 shows a strong correlation between public charging infrastructure and EV (BEV and PHEV) sales across the EU. Charging point density per 100,000 residents varies dramatically between member states, mirroring EV adoption rates. The Netherlands leads with 857 charging points and 39% EV registrations in 2024, while Italy lags behind with 75 charging points and 8% EV sales. This disparity creates a chicken-and-egg dilemma: limited infrastructure deters consumers, while low adoption discourages infrastructure investment.

25 Reuters. (2024). 'France plans to cut assistance for EV purchases by third, toughen penalties on some vehicles.'
26 Transport & Environment. (2024). *Carmaker's EV investments: Is Europe falling behind?* p. 8
27 OFV. (2024). *Nybilsalget: Helelektrisk topp 20 i oktober.*
28 The Norwegian EV Association. (2024). *Norwegian EV policy.*
29 ACEA. (2024). *Electric cars: Tax benefits and incentives.*
30 Danish Ministry of Climate, Energy and Utilities. (2020). *Climate Programme 2020.*
31 Deloitte. (2024). *Global Automotive Consumer Study.*
32 ACEA (2024). *Charging ahead: accelerating the roll-out of EU electric vehicle charging infrastructure.*

FIGURE 9: EV and PHEV adoption is correlated with uneven distribution of EV charging points across EU member states



	% of total fleet		% of total new registrations	
	BEV	PHEV	BEV	PHEV
SE	4,0	4,9	36	18
DK	3,7	3,1	33	9
NL	3,4	1,9	28	11
LU	3,1	2,6	21	9
AT	2,1	0,7	19	6
DE	2,0	1,8	17	6
FR	1,8	0,9	15	8
IE	1,4	0,9	16	7
FI	1,2	2,5	32	18
BE	1,1	2,7	18	18
LI	1,1	0,2	18	4
PT	1,0	0,9	17	12
MT	0,8	0,8	14	12
HU	0,7	0,1	3	4
HR	0,7	0,3	5	4
SI	0,6	0,1	8	2
LV	0,5	0,1	9	2
LT	0,4	0,3	7	3
IT	0,4	0,4	4	4
ES	0,4	0,5	5	6
EE	0,3	0,1	6	2
RO	0,3	0,1	10	2
CZ	0,2	0,1	3	2
SK	0,2	0,2	3	3
BG	0,1	0,1	5	1
GR	0,1	0,2	5	6
PL	0,1	0,1	4	2
CY	0,1	0,1	5	3

▲ Source: European Alternative Fuels Observatory (2024). Map reflects the most recent available data from 2023. Table data represents figures from January to October 2024.

China dominates global charging infrastructure as it does EV production, hosting 86% of the world's fast chargers and 57% of slow chargers in 2023. Europe holds 8% of fast chargers and 26% of slow chargers, while the US has 3% and 5%, respectively.[33] This gap underscores the EU's urgent need to expand charging capacity to maintain competitiveness in electric mobility.

33 Own calculation based on the data provided in International Energy Agency, 2024, Global EV Data Explorer

Integrating electric mobility policies with the EU's broader renewable energy targets is also crucial, as the environmental impact of EVs depends on the energy mix that is used to charge it. Rising EV adoption will increase electricity demand and strain grid infrastructure.

Home charging, critical for widespread EV adoption, faces challenges related to grid reliability and congestion. High electricity prices in the EU can make EV charging more expensive than fueling an ICE, deterring potential buyers.[34]

Decarbonizing transport requires synchronization with intermittent renewable energy sources like solar and wind. Without careful planning, the increased load from EV charging could overwhelm existing energy infrastructure during peak demand periods, particularly in regions with limited renewable capacity or ageing networks.[35]

Smart charging solutions could mitigate these challenges. Aligning EV charging with periods of high renewable energy generation allows smart grids to maximize clean energy use while avoiding grid strain. Vehicle-to-grid (V2G) technology enables EVs to serve as mobile energy storage, feeding electricity back to the grid during times of high demand.[36]

SCALING BATTERY PRODUCTION: THE BACKBONE OF EUROPE'S DECARBONIZATION

Scaling up battery production has become central to European decarbonization efforts. Batteries are the most valuable component of EVs and a key determinant of vehicle performance, cost, and environmental impact.

Europe's battery production, like that of the United States, lags significantly behind China's, which dominates global supply chains. Chinese companies hold significant advantages, with a decade-long head start in battery technology and the development of integrated supply chains. China's early and massive investment in battery technology since 2009, including refining capacities and critical component supply chains, puts European manufacturers at a disadvantage.[37] While the EU has announced numerous gigafactory projects, many remain unfinished, delayed, or underfinanced – Northvolt, for example, declared bankruptcy, despite significant investments and cash injections.[38] High energy and production costs, stringent environmental regulations, and fierce competition from Asian producers hamper European production, while securing large-scale investment remains challenging.[39]

Battery technology choices have significant implications for meeting near-term market demand. European OEMs have prioritized nickel manganese cobalt (NMC) chemistry for its high density, meeting consumer demands for longer range. China focuses on lithium iron phosphate (LFP), which costs 20% less per kilowatt-hour but offers 20-30% less energy density.[40] While LFP's shorter range is problematic for regions with limited charging infrastructure, NMC's reliance on volatile cobalt and nickel prices increases costs. Consequently, European battery investments may not align with mass-market EV needs.

European battery manufacturing also relies heavily on Chinese imports for critical components, with significant bottlenecks in refining and midstream production. Despite efforts in countries like Finland, Europe processes less than 10% of global raw materials. This strategic

34 European Alternative Fuels Observatory, 2022, Pricing of Electric Vehicles Recharging in Europe.

35 EU Joint Research Center, 2024, Redispatch and Congestion Management.

36 P. V. Dahiwale, Z. H. Rather and I. Mitra, 'A Comprehensive Review of Smart Charging Strategies for Electric Vehicles and Way Forward,' in IEEE Transactions on Intelligent Transportation Systems, vol. 25, no. 9, pp. 10462-10482, Sept. 2024

37 MIT Technology Review, 2023, How did China come to dominate the world of electric cars?

38 Financial Times, November 2024, Battery start-up Northvolt files for bankruptcy protection in US.

39 European Court of Auditors, 2023, The EU's industrial policy on batteries.

40 International Energy Agency. (2024). *Batteries and Secure Energy Transitions.* p. 26.

vulnerability requires both increased battery production capacity and reduced dependence on countries controlling critical raw material networks.[41]

Europe faces severe cost disadvantages in battery production. Chinese batteries cost 40–50% less than European batteries due to scale economies and lower energy costs.[42] This has led battery material suppliers with European operations, like BASF and SVolt, to reconsider their investments or exit entirely.[43] These challenges intensify as China's LFP battery production gains additional advantage from ready access to ferrous sulphate, a by-product of steel production that provides China with a cost advantage in cathode manufacturing.

Moreover, Chinese LFP battery costs have declined significantly. By mid-2024, cathode costs as a share of total LFP cell expense in China dropped from 50% to less than 30% since early 2023, reducing Chinese battery cell prices to $53 per kilowatt-hour, compared with a global average of $95 per kWh.[44] This price reduction reflects Chinese battery production overcapacity, with manufacturing output exceeding global demand. Chinese battery plant utilization fell from 51% in 2022 to 43% in 2023, as manufacturers cut prices to maintain market position.[45]

Battery supply bottlenecks and Chinese competition have driven EU policies towards establishing a robust domestic recycling ecosystem. The expected rise in end-of-life EV batteries will generate significant recyclable material volumes.[46] If all announced recycling projects proceed as scheduled, the EU's global recycling capacity share could increase from 2% to 10% by 2030, reaching a capacity of 150 GWh.[47]

The EU has already taken regulatory steps and invested millions in public funds, while attracting substantial private investment to achieve these targets. The Batteries Regulation, adopted in July 2023, aims to create a circular battery economy through recycling requirements. It mandates battery sustainability and due diligence standards, including supply chain carbon footprint disclosures. The regulation sets specific targets: 65% recycling efficiency by weight for lithium-ion batteries by 2025, rising to 70% by 2030, alongside recovery rates for critical materials and minimum recycled content thresholds.

ALTERNATIVE AND EMERGING TECHNOLOGIES FOR DECARBONIZATION

As the automotive sector accelerates decarbonization, alternative and emerging technologies may offer new options. Advances in hydrogen production and next-generation batteries could reshape battery supply chains, reduce dependencies on foreign materials, and mitigate raw material price volatility.

Fuel cell EVs, which generate electricity onboard using hydrogen, may offer a promising long-term alternative to BEVs. Their deployment remains limited, with few vehicles and refueling stations operating worldwide.[48] Scaling hydrogen production and infrastructure to meet projected demand across various sectors presents considerable challenges. The market viability of hydrogen for light vehicles requires substan-

41 For further details, please refer to the section on economic security below.

42 Bloomberg. (2024, 9 July). 'China's Batteries Are Now Cheap Enough to Power Huge Shifts.'

43 Automotive News China. (2024, 30 October). 'China battery maker Svolt pulls plug on Europe operations.'

44 Bloomberg. (2024, 9 July). 'China's Batteries Are Now Cheap Enough to Power Huge Shifts.'

45 Ibid.

46 Transport & Environment. (2024). *An industrial blueprint for batteries in Europe.*

47 International Energy Agency. (2024). *Global EV Outlook 2024*. p.145; the report also notes that 80% of global battery recycling capacity is currently located in China.

48 International Energy Agency (2024) Global EV Outlook

tial investment in electrolyzer manufacturing, transport and storage systems, and refueling networks.[49] Yet hydrogen investment remains essential for some automotive applications and decarbonizing hard-to-electrify sectors like aviation, shipping, and heavy industry.

Recent discoveries of naturally occurring hydrogen within the EU could complement other energy sources and support long-term energy diversification. Production costs are estimated at $0.50–$1.00 per kilogram, significantly below the current (uncompetitive) price of $5.00 per kilogram for green hydrogen. However, white hydrogen extraction processes remain in early development stages, requiring significant advances before large-scale viability. The International Energy Agency projects that by 2030, the levelized cost of hydrogen from renewable electricity could fall to $2.00 per kilogram in regions with excellent renewable resources, halving current costs.[50] This indicates that the path to widespread hydrogen adoption remains a possibility but is a longer-term endeavor. Significant development will be required before it can meaningfully contribute to Europe's decarbonization strategy.

Several European automakers have also proposed e-fuels as an alternative pathway to decarbonization. Stellantis, for example, announced in April 2023 the completion of e-fuel testing across 28 engine families, committing to explore e-fuels as part of its decarbonization strategy.[51] While e-fuels may offer a promising means to lower emissions in existing combustion engines, their energy-intensive production yields lower efficiency than direct electrification. BEVs achieve 77% efficiency while e-fuel vehicles operate at 16% efficiency, raising concerns about energy use and resource allocation.[52]

Hybrid vehicles represent a valuable transitional technology as the EU approaches its 2035 target for zero-emission new car sales. For many consumers, particularly in regions with limited charging infrastructure, hybrids provide a practical solution, combining an internal combustion engine with an electric motor while relying on existing fuel networks. From a manufacturing perspective, suppliers can adapt ICE supply chains to hybrid models more easily than transitioning to full EVs. Hybrids thus temporarily bridge the gap to full electrification. Some markets, such as California, will allow plug-in hybrid sales under certain conditions even after the ICE ban.[53]

Over the past decade, the EU has devoted substantial resources to low-carbon technology research and innovation, including the €40 billion EU Innovation Fund (2020–2030) designed to unlock private sector investment. While pinpointing specific breakthroughs is difficult, intensive research suggests several new battery technologies may reach mass-market-readiness by the early to mid-2030s, potentially requiring new input materials and altering battery value chains. Among the promising technologies under development are solid-state batteries (SSB), which use solid or quasi-solid electrolytes to increase energy density and improve safety through reduced flammability. Though SSB technology still faces integration challenges at the battery pack level, its potential for performance gains keeps it a priority for ongoing research.

Other innovations include sodium-ion batteries, which offer an alternative to lithium-ion batteries by using more abundant materials. Lithium-sulphur batteries, valued for their high energy density and cost-effectiveness, could also reduce dependency on scarce inputs. Lithium manganese iron phosphate (LMFP)

49 International Energy Agency (2024) Energy Technology Perspectives.

50 International Energy Agency (2024) Global Hydrogen Review.

51 Stellantis, 2023, Stellantis Finalizing eFuel Testing on 28 Engine Families to Support Decarbonization of ICE Fleet on the Road.

52 Transport & Environment, 2023, How to prevent an e-fuels loophole undermining the EU car CO_2 law.

53 If they achieve a substantial all-electric range (at least 50 miles on a single charge) and account for no more than 20% of an automaker's sales mix.

batteries, an enhanced lithium iron phosphate (LFP) chemistry, offer greater energy density by adding manganese.

Moreover, innovations in battery design, such as cell-to-pack and cell-to-chassis configurations, could increase energy density by integrating cells directly into the battery pack or vehicle chassis. Lastly, silicon anodes, which offer the potential for higher energy density and voltage, may reduce reliance on the graphite anode supply chain.

The market readiness of these and other emerging technologies will likely drive down costs, enhance battery performance, and contribute to achieving Europe's clean energy and decarbonization targets.

IV. Competitiveness

The EU automotive industry faces unprecedented challenges to its competitiveness.[54] Its historic strength in ICE manufacturing does not necessarily translate into advantages for EV production owing to fundamental technological differences, particularly the reliance on batteries. The sector's challenges are both internal and external and often intertwined.

The internal challenges stem from demand constraints, supply limitations and regulatory requirements.

DEMAND CONSTRAINTS: OVERCOMING HIGH COSTS AND CONSUMER HESITANCY

The primary demand barrier is the EV purchase price. In the European market, EVs are, on average, more expensive than comparable petrol or diesel vehicles, despite a narrowing price gap. While EVs offer lower running costs, their high upfront cost – about €10,000-15,000 more than a comparable ICE – deters many consumers, especially amid inflation and economic uncertainty.[55] Batteries alone account for up to 40% of the total cost of an EV.[56]

Consumer perceptions about EVs, including range anxiety, charging time, and battery lifespan, can also impact demand. Many potential buyers may hesitate to switch to EVs due to concerns about the technology's maturity and reliability. Limited availability of small, affordable models in the European market reinforces perceptions that EVs primarily serve wealthy consumers.

European carmakers have primarily focused on producing large, premium EVs, which are less affordable for the mass market. There are now signs that this trend is being addressed. Recent regulatory adjustments may reverse the so-called 'upmarket drift' by revising utility parameters.

In China, manufacturers have successfully targeted a wide range of consumers with smaller, lighter, and more affordable EVs. While this

54 See also the Draghi Report on 'The future of European competitiveness - a competitiveness strategy for Europe' in particular the section on the Automotive Industry. European Commission, 2024, EU competitiveness: Looking ahead - European Commission

55 International Energy Agency, 2024, *Batteries and Secure Energy Transitions*, p.28

56 *https://theicct.org/sites/default/files/publications/EU-LCV-CO2-2030_ICCTupdate_201901.pdf*

situation may be remedied, Europe still lacks affordable options in the small and medium segments, which make up 80% of European sales.[57]

As mentioned above, concerns about the availability and accessibility of charging infrastructure continue to hinder EV adoption in Europe. The EU is investing in expanding its charging network but still lags behind other regions in terms of coverage and density.[58] This is particularly problematic in less urbanized areas, where public charging options are more limited, deterring potential EV buyers. The 2023 Alternative Fuels Infrastructure Regulation establishes that, from 2025 onwards, fast recharging stations of at least 150kW for cars and vans will need to be installed every 60 km along the EU's main transport corridors.[59]

SUPPLY-SIDE CHALLENGES: MANAGING HIGH PRODUCTION COSTS

Supply-side challenges encompass high production costs, transition adaptation, lagging innovation, and input access uncertainties.

The EU faces significantly higher labor and energy costs than China, its main competitor. Wage costs in Europe are 40% higher than in China, and energy costs are double those of China and triple those of the United States.[60] These disparities make it difficult for European manufacturers to compete on price, especially in the mass-market segment where profit margins are lower. In general, production costs, especially for batteries, are higher in the EU than in China.

If not properly managed, the transition to electric mobility threatens to destabilize EU automotive supply chains. Smaller suppliers traditionally specialized in ICE components are particularly vulnerable. EV production requires different technologies and materials, such as batteries and software, which are more challenging for SMEs to acquire. The European automotive industry comprises around 17,000 SMEs that are involved in vehicle manufacturing, with major concentrations in Germany (2,757), Italy (2,167), Poland (1,717), Spain (1,623), France (1,611) and Czech Republic (1,089).[61] Many of these firms specialize in producing components for ICEs, which are more complex and numerous than those for EVs. An electric motor, for example, contains about 20 moving parts, compared with over 2,000 in an ICE. Therefore, the transition to electric drivetrains creates greater competition among firms in the supply chain.

Investment costs and funding gaps present additional challenges. Establishing and scaling EV production facilities in Europe requires significant upfront investments, often higher than in other regions. Building a battery cell factory in Europe is 47% more expensive than in China.[62] The European EV market is still relatively small, leading to limited economies of scale for European manufacturers. The smaller market size restricts the ability of European companies to reduce production costs through mass production and supply chain optimization.

Lagging innovation is also an issue in the supply of EVs, where rapid technological advancement is a decisive factor for competitiveness. Many European legacy carmakers have been slower than most of their Chinese counterparts in transitioning to EV technologies. This slower pace of innovation has allowed Chinese manufacturers to gain a technological lead, particularly in battery technology and software development. While the Chinese market remains a major growth driver for European companies, it is now also a decisive factor in staying on the technological frontier, integrating into the Chinese R&D

57 International Energy Agency, 2024, *Global EV Outlook*, p.30

58 Please refer to the section on decarbonization in this report.

59 Regulation (EU) 2023/1804 on the deployment of alternative fuels infrastructure

60 Luca de Meo, Renault Group, 2024, Letter to Europe.

61 Eurostat, 2021, Annual enterprise statistics for special aggregates of activities.

62 Transport & Environment, 2024, An Industrial Blueprint for Batteries in Europe.

ecosystem and adapting to the fierce competition from Chinese companies, with much faster model updates.

Japan and South Korea have also established an early lead in battery technology through advances in battery miniaturization driven by consumer electronics. Faced with a head start and competition from these countries, European OEMs will need to increase investment in R&D to achieve the same level of development in areas such as battery capacity, charging time, and the development of software-defined vehicles.

The United States possesses distinct advantages such as a world-class engineering and a computer science talent pool, efficient capital markets that reward innovation, and an innovative and entrepreneurial culture.[63] Self-driving technology is one area in which the US has a competitive edge. The US also has a large pool of venture capital investments. For example, in the 2018-2023 period, about 95% of venture capital investment in electric trucks, buses, and commercial vehicles happened in the US. Similarly, in the same period, start-ups based in the US attracted the most venture capital investments in batteries.[64] Overall, the US has advantages in areas such as talent, capital markets, and innovation culture.

While the EU supports innovation and R&D in EVs, including the battery production and supply chain, investment levels lag behind China and the United States. If not remedied rapidly, this R&D spending gap will widen Europe's innovation deficit.[65] Targeted R&D funding and policies that incentivize innovation in battery technology, charging infrastructure, and small- and medium-sized vehicles are key to the competitiveness of EV production.[66]

Regarding the uncertainties on access to inputs, the EU's heavy reliance on critical raw materials required for battery production, particularly lithium, cobalt and nickel, creates supply chain vulnerabilities, especially given growing competition for these minerals.[67] Heightened geopolitical tensions could further limit access to crucial EV inputs. The slow implementation of new projects related to raw material extraction and processing in Europe is also a concern. These projects face complex and lengthy approval processes, which may delay material availability, drive up costs, and discourage investment, further exacerbating the EU's reliance on imports.

REGULATORY ENVIRONMENT

Europe's regulatory requirements may hinder swift solutions to the challenges in EV supply and demand. Strict decarbonization policies, such as reducing CO_2 emissions and mandating the sale of zero-emissions vehicles by 2035, have not yet been accompanied by commensurate support measures.[68]

The challenges are further compounded by the EU's intricate decision-making process, excessive regulatory burdens, and the absence of a coherent, focused, and common strategy for the entire industry. Navigating the EU's complex regulations impacts companies' strategic planning, shaping production, investment, and market entry decisions. Additionally, the division of authority between Brussels and member states complicates governance, with fragmented

63 Russo, B. China's Auto Industry: The Race to a Sustainable Future. In *The New Center of Gravity: How China's Automotive Industry is Shifting the Global Landscape* (2024).

64 International Energy Agency, 2024, Energy Technology Perspectives 2024.

65 International Energy Agency, 2024, Energy Technology Perspectives 2024.

66 ACEA reports that Europe leads global automotive innovation with an annual investment of €59.1 billion in R&D, surpassing Japan (€31.7 billion), the United States (€22.4 billion), and China (€14.3 billion). R&D investment in the automobile sector, by world region - ACEA. However, this data is not disaggregated into R&D investments for ICEs versus EVs and appears to exclude R&D related to batteries and their supply chain.

67 Please also refer to the section on economic security in this report.

68 Please also refer to the section on decarbonization in this report.

responsibilities for various measures. Overlapping mandates among different Commission departments – spanning trade, industrial, competition, and climate policies – further create ambiguity and inefficiencies.[69]

A lack of coordination between different regulatory bodies within the EU has also created a fragmented approach to vehicle regulations. Each agency focuses on its specific mandate without necessarily considering the broader implications for the automotive industry. This may result in unintended negative consequences for the industry. This siloed approach has hindered the development of a coherent strategy for EV development and production.[70]

EXTERNAL CHALLENGES

The European automotive industry also faces significant external challenges, including intense competition from China in finished products and batteries, measures such as subsidies and trade barriers in the US, and limited access to critical raw materials.

China has established itself as a global leader in the EV market, benefiting from a decade-long head start, vast industrial policy support, and a government-mandated push for electrification. In contrast, the US has followed a more protectionist approach, accelerating its EV advancements through subsidies provided under the Inflation Reduction Act (IRA) while largely excluding Chinese EVs from its market via high tariffs and restrictive measures justified by national security considerations. Europe, meanwhile, remains more open to Chinese competition, but its policy responses lack coherence and remain fragmented.

China's EV strategy has profoundly impacted the EU automotive sector, creating a complex landscape of competition, trade tensions, collaboration, and contribution to decarbonization. The EU now faces the dual challenge of pursuing its ambition to lead the global EV transition while supporting its domestic industry and ensuring fair competition with its major trading partners.

China's rapid development of a cost-competitive EV industry has fueled a surge in its exports. By 2023, Chinese EV brands held 7.9% of the EU market for EVs, a remarkable jump from just 0.4% in 2019. However, following the EU's imposition of countervailing duties in October 2024, S&P predicts that the market share of Chinese brands in the overall EU passenger car market will stabilize between 5% and 10%.[71]

It is important to distinguish between Chinese brands and EVs produced in China. Western firms, such as Tesla, BMW, and Dacia (Renault Group), also manufacture EVs in China and export them to the EU, adding another layer of complexity to managing competitive relations with China. This is further complicated by the longstanding presence of European firms producing ICEs in China. According to T&E, the share of Chinese-made EVs – including models from EU brands – is projected to peak at approximately 25% in 2024, before declining to 20% in 2025 and around 18% of BEV sales by 2026.[72]

China's success in establishing itself as the most competitive producer of EVs and batteries is based on its early and strategic decision to develop and support this technology ahead of other competitors, its vast domestic market and economies of scale, its dominance in the battery supply chain, its focus on affordable models, and its rapid technological advancement.[73]

The Chinese government has supported the development of EV technology and its commercial use on a vast scale. The government has granted and continues to grant generous sub-

69 GERPISA, 2024, European Regulations for an affordable sustainable (battery) electric vehicle.
70 Ecole Polytéchnique, 2023, A comparison of the Chinese, European and American Regulatory Frameworks for the Transition to a Decarbonized Road Mobility.
71 S&P, 2024, Fuel for Thought: How EU Tariffs Will Impact the Battery Electric Vehicle Market.
72 T&E, 2024, Trade defence: Where's next for the EU's EV and battery trade policy.
73 MIT Technology Review, 2023, How did China come to dominate the world of electric cars?.

sidies for producing vehicles and components. This has raised concerns about a 'level playing field' in the competition of EVs produced in China with those made in Europe.

In October 2023, the EU Commission launched, on its own initiative, a countervailing duty (anti-subsidy) investigation into imports of EVs from China. The investigation stemmed from concerns about the impact of government subsidies on the competitiveness of Chinese EVs and the resulting harm to European producers caused by these subsidized imports.

Following the investigation and imposition of provisional duties, the EU Commission imposed definitive countervailing duties on EVs from China on 29 October 2024.[74] The countervailing duties entered into effect on 31 October 2024 for a period of five years.

The countervailing duties are imposed on a company-specific basis, with each company representing a group of firms. These duties are applied in addition to the standard 10% *ad valorem* duty and vary according to the brand, the extent of its cooperation with the Commission's investigation, and the documented level of subsidies it has received.[75]

The decision-making process among EU member states, including their individual positions and the reasons behind them, has drawn significant attention. Equally scrutinized are China's responses to the imposition of definitive duties and the measures it has taken in retaliation.

On 8 October 2024, China's Ministry of Commerce announced temporary tariffs of up to 39% on European spirits, widely perceived as retaliation for the EU's countervailing duties on Chinese EVs. Reports also suggest possible duties on pork, dairy products, and gasoline cars with large engines. Additionally, on 10 October 2024, China's Ministry of Commerce reportedly urged Chinese automakers to halt large-scale investment plans in EU countries that supported the countervailing duties.[76] This directive has already resulted in announcements of changes to the locations of planned investments.[77]

Despite competitive tensions, dialogue and negotiations between Chinese and EU authorities remain ongoing. Opportunities for cooperation also exist, as Chinese carmakers increasingly invest in production facilities within the EU, drawn by the region's strong purchasing power and its commitment to phasing out internal combustion engines. These investments have the potential to create jobs and stimulate economic activity in the EU. However, they also raise concerns about overcapacity and future challenges to the dominance and brand loyalty of European manufacturers. Localizing production in Europe could help Chinese companies mitigate the effects of the EU's countervailing duties. At the same time, greater access to Chinese brands for European consumers could address quality and safety concerns, improving their reputation and market acceptance.

Chinese EV manufacturers are making notable investments in Europe. In particular, BYD is building an EV assembly plant in Hungary, scheduled to begin production in 2026 with a capacity of 200,000 vehicles. Similarly, Chery, through a joint venture in Spain, plans to produce 150,000 vehicles annually by 2029, positioning the facility as an export hub.[78] Additionally, some Chinese carmakers have established R&D and design centers across Europe.[79] While trade

74 Commission Implementing Regulation (EU) 2024/2754, 29 October 2024, Implementing regulation - EU - 2024/2754 - EN - EUR-Lex.

75 The countervailing duties are as follows: Tesla: 7.8%; BYD: 17%; Geely: 18.8%; SAIC: 35.3%; Other EV producers in China that cooperated in the investigation but were not individually sampled: 20.7%; Other EV producers in China: 35.3%.

76 Reuters, 31 October 2024, China tells carmakers to pause investment in EU countries backing EU tariffs.

77 Reuters, 11 November 2024, Stellantis, partner Leapmotor scrap plan to make second EV model in Poland.

78 Transport & Environment, 2024, Carmakers' EV investments: Is Europe falling behind?

79 NIO, 2024, NIO expands its international footprint and sets new standards in driving safety and comfort with new European Smart Driving Technology Center.

policy is an exclusive competence of the EU, investment policy is largely a shared competence, with FDI screening remaining the responsibility of individual member states.

In the US, the substantial subsidies provided to the automotive and high-tech industries through the IRA present a significant external challenge to the EU industry. Unlike the EU, which lacks a comparable comprehensive funding scheme, the IRA offers tax credits and incentives specifically designed to bolster domestic EV and battery production. This has made the US an attractive destination for EV and battery manufacturing investments, even for European carmakers. While increased investments in the US have not necessarily led to a decrease in EU investment overall, the IRA's distortive effects are particularly evident in the battery production sector. Estimates suggest that up to half of the planned battery production capacity in Europe over the next five years is at risk due to competition spurred by the IRA.[80]

As a result, the IRA intensifies competition and creates possible delays and distortions in investment decisions, adversely impacting the European automotive industry.

The impact of the Trump administration on EV production and marketing remains uncertain. Potential changes to the IRA and the termination of consumer subsidies could significantly affect the industry, particularly legacy companies that rely heavily on these subsidies to increase their market share. Tesla stands to gain from the removal of such subsidies, given its dominant position in the US EV market (accounting for half of sales in 2024) and its established economies of scale.[81] Meanwhile, a potential rollback of emissions regulations could give other producers more time to adapt to the EV transition, although this would likely delay the decarbonization of the US transportation sector.

In May 2024, the Biden administration announced significant tariff increases, raising duties on EVs imported from China from 25% to 100% and on Chinese lithium-ion batteries from 7.5% to 25%. These measures, introduced under a so-called Section 301 investigation, have drawn criticism for potentially violating the World Trade Organization (WTO) obligations of the US. Additionally, the proposed US government ban on Chinese software and hardware in connected and autonomous vehicles would effectively exclude Chinese cars from the US market. This exclusion could prompt Chinese EV manufacturers to shift their focus to the EU market to compensate for lost access to North America. Such a move could intensify competition for European manufacturers, particularly in segments where Chinese brands excel, such as compact cars. An additional challenge for the European automotive industry is the sourcing of critical raw materials for batteries, which is dominated by China in both mining and refining.[82]

Several other countries have also raised tariffs on Chinese EVs or EVs manufactured in China. In July 2024, Brazil imposed an 18% tariff, ending a period of zero tariffs that had been in place since 2015. Similarly, in September 2024, Canada announced that tariffs on EVs originating in China (including Tesla) would increase from 6.1% to 100%.

THE INDUSTRY REMAINS PROFITABLE, BUT THE TRANSITION POSES CHALLENGES

Despite these challenges to its competitiveness, Europe retains significant advantages in the automotive sector. These include a highly skilled workforce, a large domestic market, and extensive R&D capabilities. European automakers continue to be profitable, both in absolute terms and relative to their global peers, although profitability varies between companies (see Figures

80 Transport & Environment, 2024, An Industrial Blueprint for Batteries in Europe.

81 Financial Times, 14 November 2024, Trump's shake-up of EV rules would be 'huge positive' for Tesla.

82 Please also refer to the section on economic security in this report.

10 and 11 below). Suppliers, however, have lower profit margins than OEMs and may be more impacted by the transition to EVs.

A significant portion of automotive companies' profits still comes from the sale of ICEs. According to the EU Commission Implementing Regulation on provisional countervailing duties, 'the (European) Union industry was still far from making a profit on BEVs. The situation in the investigation period of losses over 10% and continuing price suppression jeopardized the entire transition of the Union industry from ICEs to BEVs.'[83] For now, manufacturing EVs in Europe is not as profitable as producing ICEs, but this may change as economies of scale improve and battery costs decline.[84]

The profitability of most European carmakers stands in contrast to the low profits reported by Chinese manufacturers and the relatively lower margins of American companies.

As noted above, the situation for suppliers is different. Some, such as ZF and Valeo, operate with comparatively low profit margins, and suppliers overall may be among the companies most affected by the transition to EVs. According to a McKinsey survey of 120 EU automotive suppliers, 38% expect to operate at a loss or achieve only marginal profitability in 2024, with 35% expecting similar conditions in 2025.[85] This trend warrants particular attention given suppliers' contributions to local economies and their role in ensuring labor stability across many European regions.

Of course, the current profitability of European OEMs must be viewed in the context of the ongoing transition to EVs. This shift requires substantial investments to adapt established production infrastructure, retrain the workforce, restructure commercial relations, and expand R&D efforts. Innovation will be a key factor for the competitiveness of the EU automotive industry. The high profit margins achieved in recent years are essential to support the sector's move towards decarbonization.

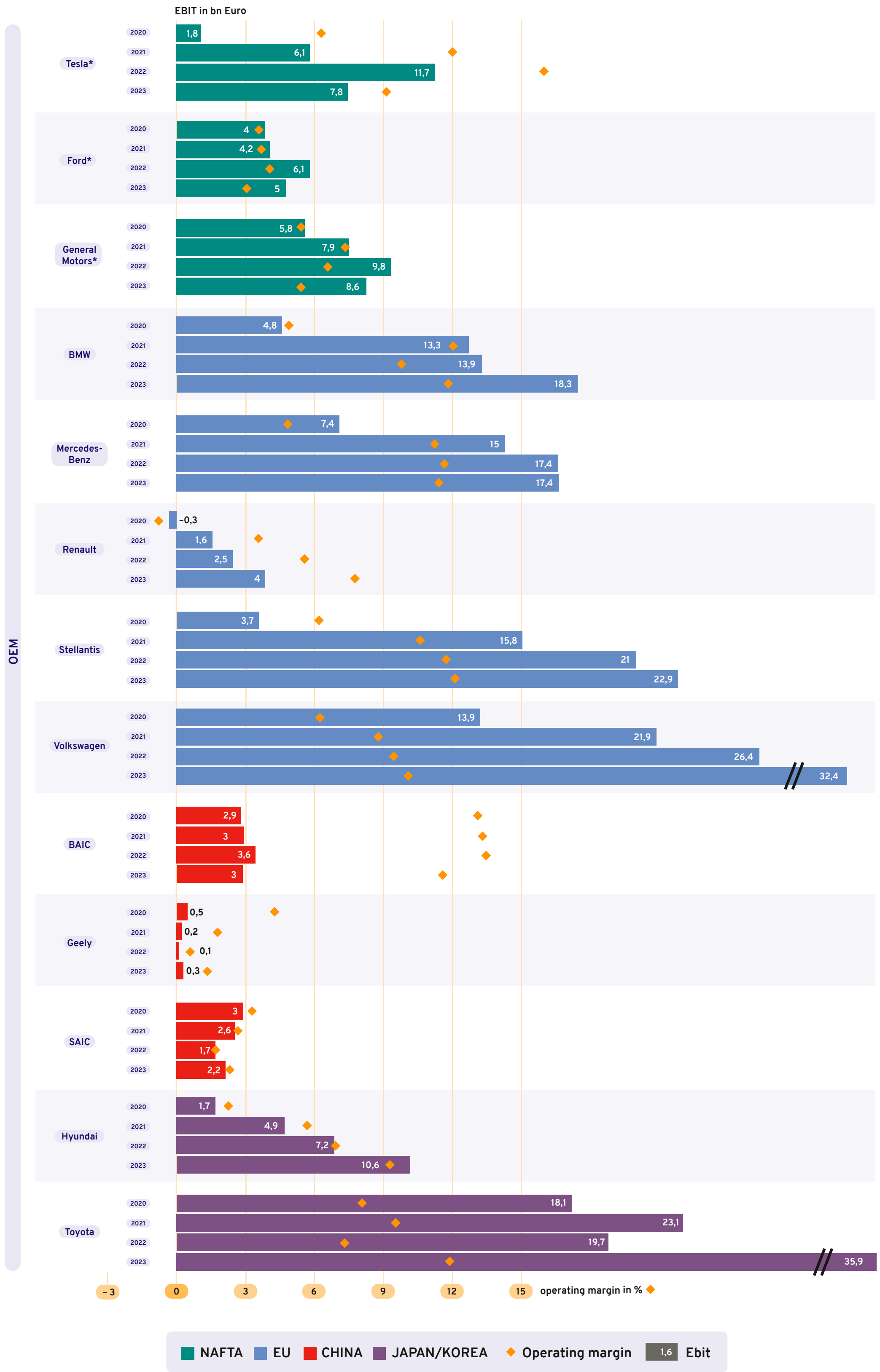
Recent data indicates that OEMs are facing increasing financial and operational pressures, with a downturn in earnings and reduced profit margins in 2024. Rising input costs and stalled EV demand growth in the European market have likely contributed to a more precarious environment for OEMs. In response, some manufacturers have implemented production adjustments, plant closures, and workforce reductions – signals that financial strain may be spreading across the supply chain.

83 Commission Implementing Regulation 2024/1866, para 1101.

84 Commission Implementing Regulation 2024/1866, para 1088.

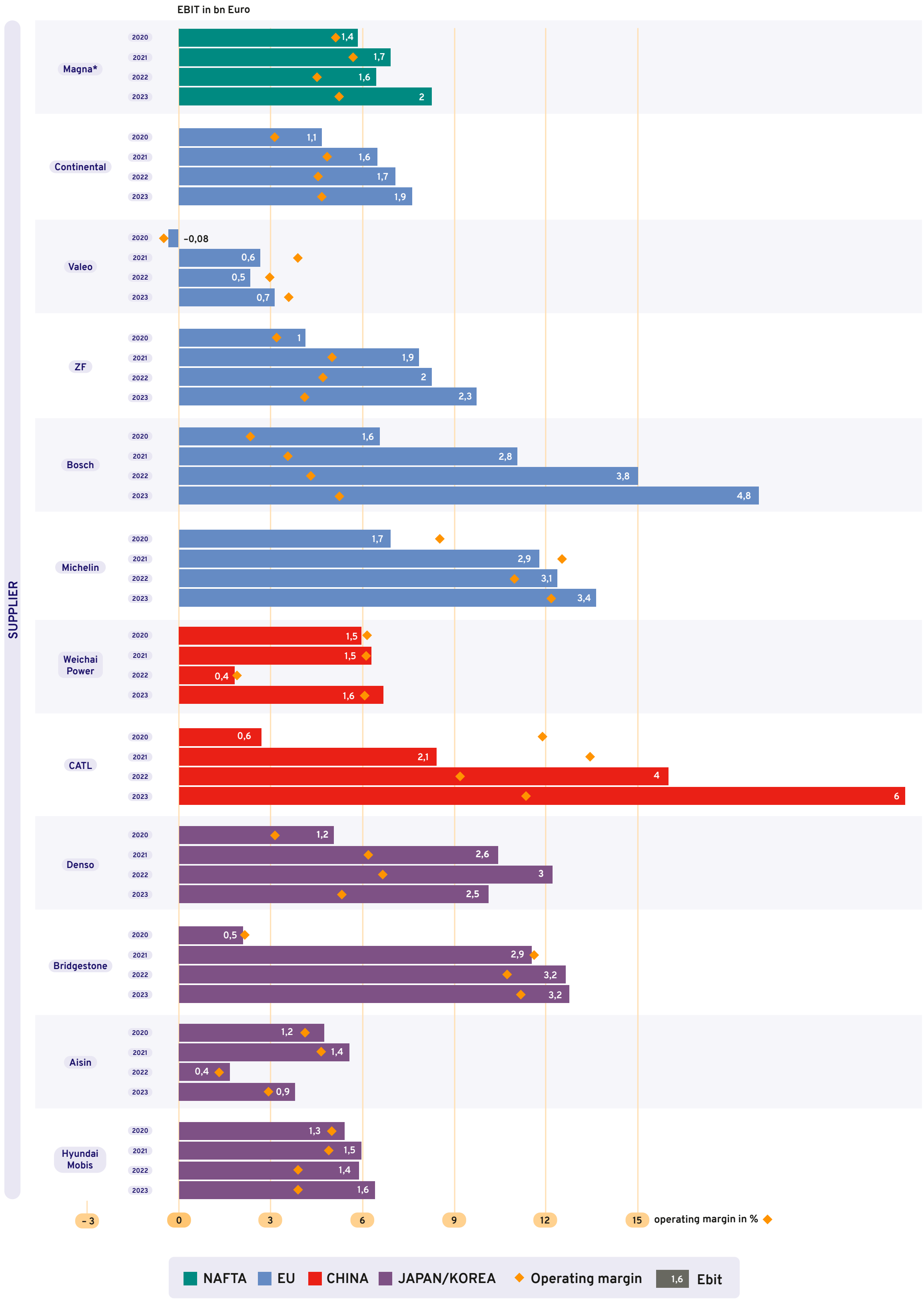
85 CLEPA, 2024, Grim outlook for European automotive suppliers, as lower volumes suppress profitability.

FIGURE 10: European OEMs remain profitable, both in absolute and relative terms



▲ Source: Moody's BvD-ORBIS (2024), *annual income statements.
National currency values are transferred into euros based on average yearly exchange rates.

FIGURE 11: Suppliers have low profit margins and may be most affected by the transition



▲ Source: Moody's BvD-ORBIS (2024), *annual income statements.
National currency values are transferred into euros based on average yearly exchange rates.

V. Economic security

The transition of the automotive industry is unfolding against the backdrop of geopolitical tensions that are reshaping global trade networks, supply chains, and investment flows. If campaign pledges are kept, the Trump administration will usher in a wave of new tariffs on imports, posing significant challenges to Europe's automotive strategy. Proposed US tariffs of up to 60% on Chinese imports would not only strain the Chinese economy but also lead to a substantial decline in bilateral trade with the US, increasing the risk of trade diversion towards the EU.[86]

In addition, the application of 25% tariffs on Mexican and Canadian imports, announced on 25 November, would restrict opportunities to circumvent tariffs on Chinese imports by investing in Mexico's automotive sector. With the Chinese automotive industry contributing around 10% of China's GDP, its role in driving economic growth will become even more important as bilateral trade with the US declines. Access to the European market will thus be increasingly important for China to maintain and grow its EV sales.[87]

Conversely, despite European automakers experiencing a loss of market share in China, the market remains significant for many of them. China and the EU will be increasingly bound by the challenge of growing interdependence on each other's markets, which will make compromises more necessary but also more delicate.

This section examines how the rapid geopolitical transformation of the global trading system heightens economic security concerns for the decarbonization of the automotive industry. Beyond the risk of weaponizing the supply of critical components for coercive reasons, the connectivity of modern cars calls for addressing cybersecurity risks, including the potential collection of sensitive data by foreign governments. Additionally, the transition's impact on

86 CEPII, 2024, Trump 2.0 Tariffs: What Cost for the World Economy?

87 Li F. (2024), Nation's vehicle output, sales hit record in 2023, China Daily, 12 January 2024.

jobs could translate into social and political instability, further complicating the industry's path to decarbonization.

AUTOMOTIVE SUPPLY CHAINS ARE ONLY ONE PART OF A LARGER PUZZLE

Advances in digital technology, while offering countless new opportunities, have also introduced vulnerabilities, intensifying the geopolitical rivalry between the United States and China over technological dominance. This competition has fueled a wave of trade and investment restrictions, framed not only as responses to economic disputes but also as central components of national security agendas. In an interconnected global economy, economic security measures reverberate across borders, disrupting production networks and raising the risk of retaliatory escalations that could further fragment the international trading system.

To preserve the economic sovereignty and political stability of the EU and its member states, a forward-looking strategy for the European automotive industry must be comprehensive enough to safeguard the EU's economic security. Decarbonization efforts should remain closely linked to risk mitigation measures, by building resilience against geopolitical risks.

In March 2023, the European Commission signaled that the EU intends to pursue a strategy of de-risking rather than decoupling from Chinese value chains. This approach is part of an emerging economic security doctrine aimed at safeguarding European policies and resources from external interference or excessive dependence. By prioritizing de-risking, the EU seeks to mitigate geopolitical and geoeconomic risks while maintaining a level playing field in global trade. Recognizing the high costs of economic security measures, the Commission has narrowed the scope of de-risking to four key areas: ensuring resilient supply chains, securing critical infrastructure against physical and cyber threats, protecting technological assets and preventing technology leakage, and countering the weaponization of economic dependencies through coercion.[88]

The decarbonization of Europe's car fleet will, therefore, also be a top priority on the economic security agenda of the new European Commission. The growing risk of coercion tied to the supply of EV components is exacerbated by the ripple effects of the US-China confrontation, which increasingly pressures the EU and other nations to align their supply chains with one geopolitical bloc over the other. Meanwhile, the deep integration of digital technologies in new cars and charging infrastructure introduces additional vulnerabilities, including cybersecurity risks and the potential of collection of sensitive data by foreign governments. Calibrating the EU's strategy for the automotive transition will not only address its idiosyncratic challenges but also serve as a test case for developing the European de-risking doctrine.

ADDRESSING THE RISK OF WEAPONIZATION OF SUPPLY FOR COERCIVE OR RETALIATORY PURPOSES

The EU seeks to address the high concentration of battery supply chains at the level of three key bottlenecks: the mining of critical minerals, their processing, and the production of cathodes and anodes. In addition to reducing existing dependencies, the EU also aims to prevent the emergence of new dependencies that could arise from controlling and transferring sensitive data from connected vehicles.

Although the EU's imports of batteries from China declined between 2013 and 2023, it remains heavily reliant on Chinese supply chains for cathodes, anodes, and assembled batteries. Figure 12 highlights China's dominance across the EV supply chain: it accounts for 92% of global anode production and 81% of cathode production for EV battery cells. Most of these materials remain within China, where 77% of

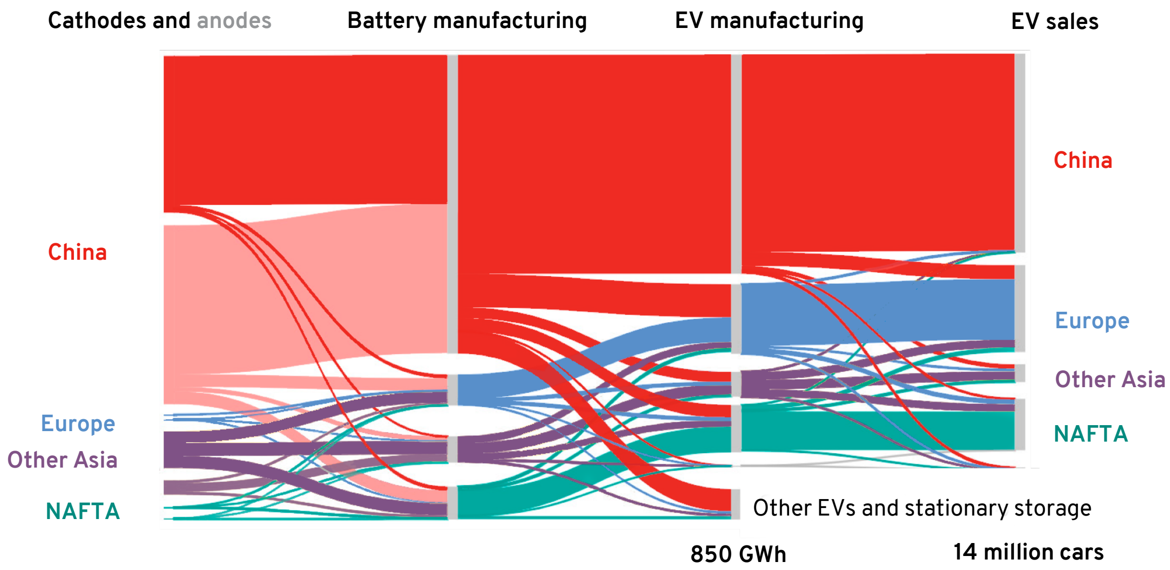
88 Commission Recommendation (EU) 2023/2113 of 3 October 2023 on critical technology areas for the EU's economic security.

EV batteries are produced. As described above, localization is so strong that nearly three-quarters of the remaining batteries are used in EV production within China itself.

As the largest consumer of EVs, China retains most of its domestically produced batteries. Other regions, however, are particularly dependent on China for upstream components in the EV supply chain. Europe, for example, imports over 80% of its anode demand, 72% of its cathode demand, and 52% of the batteries used in its EVs from China.

FIGURE 12: Significant local production hides the dominance of Chinese industrial capacity in global EV value chains

Global manufacturing and trade flows of EVs and lithium-ion batteries, in 2023.



▲ Notes: Flows are normalised to the battery (cell) manufacturing step, with cathodes and anodes normalised such their sum is scaled to the battery cell volume. Numbers below the charts refer to the total demand, not only the traded volume. The lighter-colour version of the flows going to battery manufacturing represents the anodes.
Europe = EU + Albania, Belarus, Bosnia and Herzegovina, Gibraltar, Iceland, Israel, Kosovo, Montenegro, North Macedonia, Norway, Republic of Moldova, Serbia, Switzerland, Türkiye, Ukraine and United Kingdom
Other Asia = Asia excluding China
EV=BEV+PHEV

▲ Source: IEA (2024), Energy Technology Perspectives 2024, IEA, Paris
https://www.iea.org/reports/energy-technology-perspectives-2024, Licence: CC BY 4.0

An emerging trend is the increasing dependence on Chinese battery production facilities within Europe. While this local presence mitigates some logistical challenges, it nevertheless perpetuates strategic vulnerabilities, especially as Europe continues to lag in upstream capacities like mining and refining. Closing these gaps will be critical for the EU to build resilience across the entire battery value chain and reduce its exposure to geopolitical risks associated with over-reliance on a single country.

Estimates suggest optimism about the ability of European battery production to meet the region's 2030 EV demand.[89] However, achieving the goal of sourcing approximately 80% of the battery supply locally would rely on a mix of European and international companies establishing production facilities. Notably, Chinese manufacturers are playing an increasingly significant role in this expansion. For example, CATL began production in Germany in 2023 and announced new plants in Hungary (2022) and Spain (2024). Similarly, BYD is expected to begin its production in Hungary by mid-2025.

Two Important Projects of Common European Interest (IPCEI) were launched in 2019 and 2021 to scale up battery production in the EU.[90] However, waste levels remain high and the learning curve is longer than expected. Achieving the economies of scale necessary for European battery manufacturers to grow may prove even more difficult due to shifting industry priorities. Significant investments in technologies like NCM are now being undermined as several OEMs, including Stellantis, Mercedes, and Renault, pivot towards LFP chemistries to reduce costs.[91]

European manufacturers are facing growing competition from low-cost Chinese LFP batteries. They are exposed to the risk of global overcapacity as electric vehicle sales fall short of expectations and Chinese battery production already matches global demand.[92] However, their most pressing vulnerability lies in their overwhelming dependence on imported critical minerals. As shown in Figure 13, the sector's reliance on unprocessed critical minerals, coupled with Europe's minimal and stagnant refining capacity, has emerged as a significant economic security challenge for the European automotive industry.

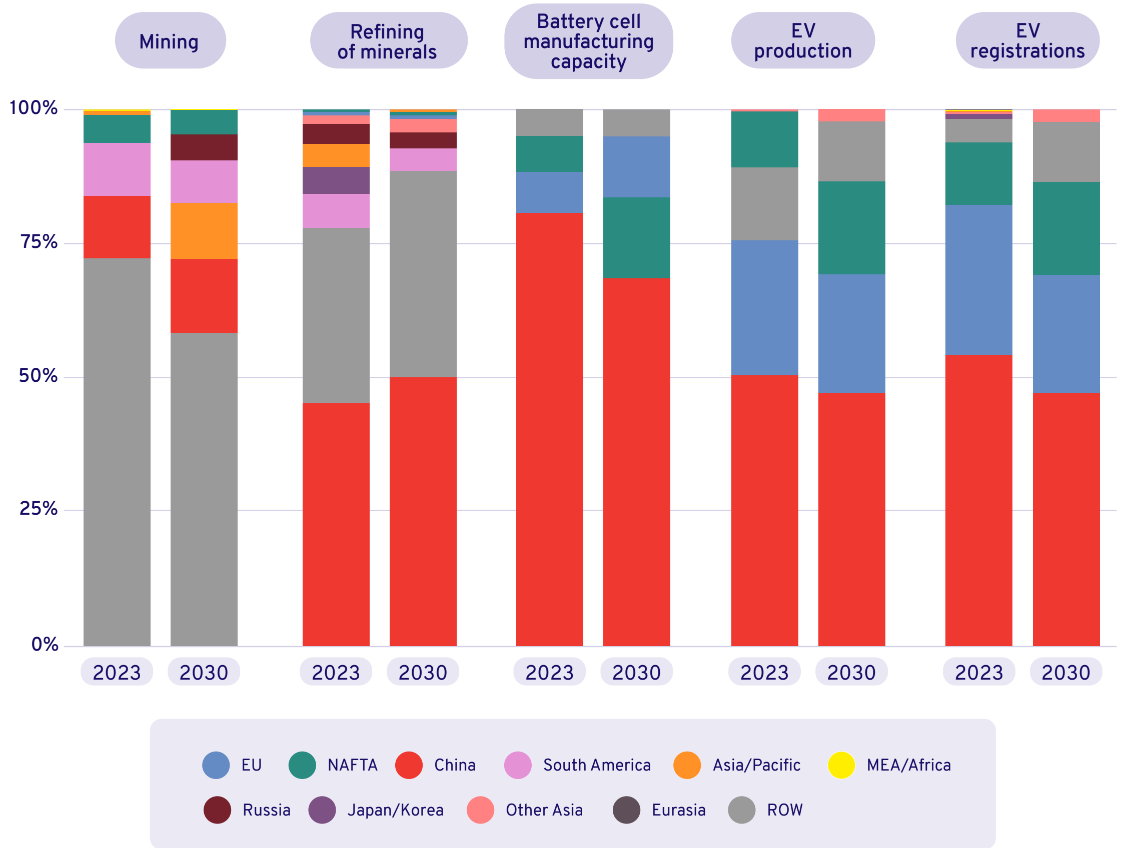
89 European Court of Auditors, 2023, The EU's industrial policy on batteries New strategic impetus needed.

90 Important Project of Common European Interest (IPCEI) on Batteries.

91 LFP batteries account for less than 10% of EV sales in Europe, with NCM batteries remaining the most widely used. IEA (2024), *Global EV Outlook*; Cimino, V. (2024) 'En plein doute, Stellantis et Mercedes mettent en pause des projets d'usines de batteries en Europe,' *Automobile Propre*, 6 June 2024.

92 Girling, W. (2024) Europe's battery industry struggles with global overcapacity, Automotive World, 20 September 2024. McKerracher, C. (2024) China Already Makes as Many Batteries as the Entire World Wants, Bloomberg, 19 April 2024.

FIGURE 13: China's dominance in global EV supply chains is projected to continue in the mid-term
Share of global production in % in 2023 and pledged scenario 2030.



▲ Source: IEA 2023/2024

The supply of minerals essential for battery manufacturing is highly concentrated in a few countries. The Democratic Republic of Congo produces 55% of the world's cobalt, while Chile accounts for 33% of lithium. Graphite production is dominated by China (28%) and Brazil (26%), while nickel supplies are concentrated in New Caledonia (25%), Indonesia (22%), and Australia (22%). This presents significant supply chain risks and calls for diversification and increased domestic capacity to reduce vulnerabilities in the battery value chain.[93]

Following the adoption of the European Critical Raw Materials Act in May 2024, which set a target of meeting 10% of the EU's demand for critical minerals from domestic sources by 2030, member states have taken steps to develop more ambitious mining policies. While Finland and Sweden already have established mining activities, France and Germany have shown particular interest in advancing mining projects and boosting domestic capacity through strategic partnerships and exploration efforts within Europe. However, environmental concerns and public opposition are slowing down the approval and expansion of new mining initiatives.

In recent years, the concentration of mining capacity has increased, with China solidifying its dominant position in extracting critical raw materials from resource-rich countries. Under its 13th Five-Year Plan (2016–2020), China launched 'a decisive battle for the non-ferrous

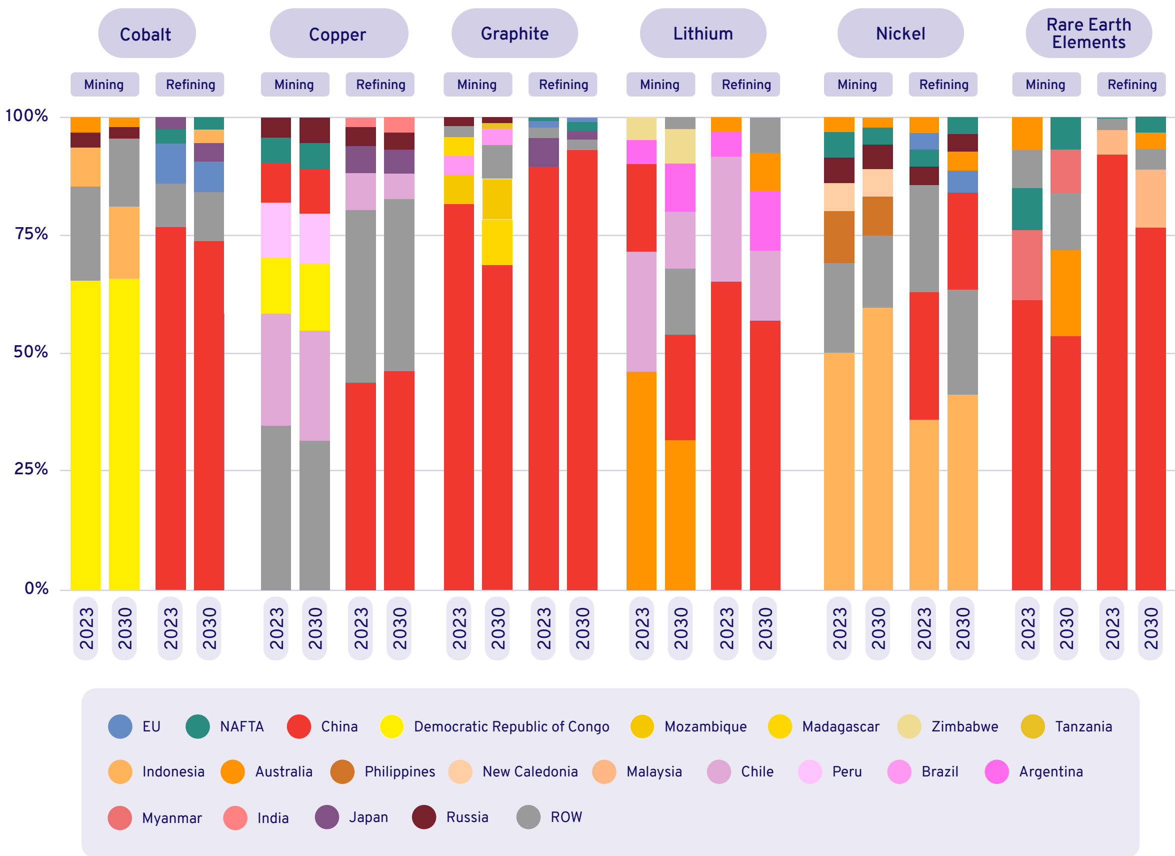
93 United States Geological Survey, 2024, Mineral Commodity Summaries 2024.

metals industry,' aimed at securing a stable supply of critical minerals for which it has limited or no domestic reserves while expanding its global leadership in these resources (Figure 13). This strategy has been supported by substantial foreign direct investment in Latin America, Africa, and the Asia-Pacific region, as well as the consolidation of competitive Chinese conglomerates to challenge traditional foreign investors. Although Figure 13 shows China's domestic mining capacity, its overall production capacity is even more significant when factoring in its extensive investments in third countries.

Figure 14 illustrates another critical bottleneck: the geographical concentration of refining operations in China. In the 1990s, the United States, the EU, Japan, and other countries outsourced much of their refining capacity to China to lower costs and mitigate domestic environmental impact. This strategy has allowed China to establish a near-monopoly in refining key minerals such as graphite, cobalt, and rare earth elements, while also maintaining a dominant role in the refining of copper and lithium. In some cases, such as graphite, China's dominance continues to grow.[94] China accounts for 98% of the world's graphite refining,[95] 59% of lithium processing for battery anodes, and 93% of manganese refining. China also refines 82% of cobalt, over 80% of rare earth elements, and 65% of nickel.[96]

FIGURE 14: China between dominance and monopoly in the upstream of the EV supply chain

Share of global production in % in 2023 and pledged scenario 2030.



▲ Source: IEA 2023/2024

94 IEA (2023), Critical Minerals Market Review 2023.

95 IEA (2024), Global Critical Minerals Outlook 2024.

96 Benchmark Mineral Intelligence (2020) in Capliez, R. and alt (2024), *Batteries lithium-ion : cartographie dynamique de la chaîne de valeur et perspectives*, Policy Brief, n°48, October 2024.

Similar to mining, increasing the EU's refining capacity will depend on achieving greater domestic acceptability, which is unlikely without significant investment in R&D to make the mining and refining industry more environmentally friendly.

Recent trends in European refining capacity for two key battery minerals, lithium and nickel, highlight the scale of the challenges in diversifying supply and the lengthy timeline required to achieve it. The EU is investing in a domestic lithium refining capacity, aiming to reach around 615kt of lithium carbonate equivalent (LCE) by 2030 – enough to theoretically meet the EU's projected demand.[97] However, many projects remain in their early stages and depend heavily on continued investment to move forward. Over the next two years, only two projects are expected to come online, offering a combined capacity of 31kt LCE – one operated by AMG Lithium in Germany and the other by Keliber in Finland.[98] Additionally, BMW has partnered with Livent Corporation to secure a stable and reliable supply of lithium.[99] For nickel sulphate, the EU's current refining capacity is approximately 63kt, which will meet only 20% of the EU's anticipated demand by 2030.[100] Existing facilities include operations run by Terrafame and Nornickel in Finland, as well as Hellenic Minerals in Cyprus. These figures highlight substantial gaps in Europe's supply chain and the urgent need for strategic investment to address them.

Outside of China, only South Korea and Japan hold significant shares of the global manufacturing capacity for cathode active materials, at 9% and 3%, respectively. In contrast, China produces almost 100% of the world's lithium iron phosphate (LFP) and more than 75% of lithium nickel manganese cobalt oxide and other nickel-based chemistries. South Korea is the next largest producer for nickel-based chemistries, accounting for 20% of global production capacity.[101]

In 2018, the EU experienced a nickel export ban from Indonesia, which now represents 60% of global nickel refining capacity.[102] A future export ban on certain critical minerals from China could force EU OEMs to shut down their EV production within weeks. Therefore, recent Chinese export restrictions on critical minerals are cause for concern. Currently, 90% of the anode active material used in Europe comes from China. Between 2020 and 2023, Swedish battery manufacturer Northvolt was cut off from Chinese supplies, illustrating the negative impact such disruptions can have on a nascent industry. China's export controls on gallium, germanium, and graphite, implemented since 2023, were announced in response to Dutch company ASML aligning with US restrictions on exports to China of technologies for chips manufacturing and the EU's anti-subsidy investigation into EV imports from China. More recently, on 3 December 2024, China banned exports of gallium, germanium, and antimony to the US and imposed stricter controls on graphite exports, retaliating against new export restrictions from Washington.

At the same time, the pace of diversification in the supply of battery components lags behind battery demand growth, driven by the need to comply with the short-term 2025 and mid-term 2030 CO_2 emissions reduction targets. This urgency may further increase reliance on Chinese-refined minerals, as the EU seeks to secure sufficient materials to meet deadlines. Consequently, the EU's dependency on Chinese supply chains could deepen, even as efforts to diversify – such as scaling up processing capacity within the EU or in other third countries – gradually progress.[103]

97 Transport & Environment, 2024, An Industrial Blueprint for Batteries in Europe.

98 Idem.

99 S&P Global, 2021, BMW signs Eur285 million lithium supply deal with Livent.

100 Idem, p26.

101 International Energy Agency, 2024, Global EV Outlook, p.80.

102 International Energy Agency, 2024, World Energy Outlook.

103 Complying with the 2025 target of reducing CO_2 emissions from 95 g/km to 81 g/km on average for a brand's new vehicle sales.

The EU aims to work with trading partners to promote responsible mining and processing practices that adhere to high social and environmental standards, as well as ensure transparency and traceability in supply chains. Recent trade agreements with New Zealand, Chile, and Mexico, and ongoing negotiations with Indonesia, include chapters on Energy and Raw Materials aimed at establishing market principles and creating a cooperative framework to harmonize standards and regulatory practices. However, the substantial R&D investments required for the greening of refining processes could prompt concerns about the penalties that could potentially be imposed for non-compliance with CO_2 emission reduction regulations. Several European OEMs have already started investing in sustainable mineral extraction and processing. Volkswagen, Stellantis, and Renault, for example, are investing in Vulcan Energy Resources to source lithium with minimal environmental footprint. BMW has invested in US start-up Lilac Solutions, which is developing innovative methods for sustainable lithium extraction. But potential penalties may reduce the capacity of non-compliant OEMs to invest in sustainable practices.

Critical minerals stocks are essential but are constrained by significant price fluctuations and the mid-term deterioration of these minerals. To reduce the risk of supply shortages, there is a strong push to adopt circular economy principles. For instance, BMW is actively investing in recycling initiatives to recover critical minerals from end-of-life vehicles and production scrap. Pooling purchases of critical minerals could also increase bargaining power, allowing countries or companies to secure better prices and more favorable terms from CRM suppliers. It could reduce risks by diversifying sources, lessening the dependency on any single supplier and mitigating supply chain vulnerabilities. Additionally, joint purchasing initiatives could promote sustainable practices by encouraging CRM suppliers to adopt eco-friendly extraction and production methods. However, there are challenges to consider, including the complexity of coordinating such a mechanism, which would require close collaboration among participants; differences in objectives and priorities could lead to competing interests, hindering collective decision-making; joint purchasing could also carry risks of collusion and anti-competitive practices.

In the current context of escalating geopolitical tensions and retaliatory measures, the concentration of sales markets can also create vulnerabilities. There is currently no alternative to the size and growth of the Chinese market for some European OEMs and suppliers. However, this exposure carries increasing risks, especially if the share of sales in China grows faster than the share of sales in other markets.

ANTICIPATING CYBERSECURITY THREATS: CROSS-BORDER DATA FLOWS AND CONSUMER TRUST

New cars are equipped with a wide array of sensors and connected systems that collect and transmit sensitive data, exposing automotive supply chains to heightened cybersecurity and data security threats. The interconnectedness of cars and EV charging infrastructure creates multiple potential entry points for hackers. Cyberattacks can compromise vehicle safety, breach privacy, and undermine data integrity, potentially resulting in costly recalls and significant reputation damage for manufacturers. In addition, there are concerns about sensitive data collection by vehicles equipped with foreign technology. Suppliers must invest in costly, robust cybersecurity measures, including advanced encryption, intrusion detection systems, and regular security audits, to avoid eroding consumers' trust and jeopardizing national security.

Current EU regulations (including the GDPR, horizontal cybersecurity rules, and ePrivacy Directive) provide a strong basis for ensuring secure and lawful data processing. However, they do not fully address the challenges posed by data transfers from autonomous driving systems, especially when real-time processing or cloud-based services are involved.

The US has accelerated efforts to decouple its automotive supply chains from Chinese technologies, citing national security concerns. In September 2024, the Biden administration proposed a ban on Chinese software and hardware in connected vehicles operating on American roads. The proposed timeline includes software restrictions starting in 2026 and hardware restrictions by 2029.

In the EU, national security falls under the jurisdiction of member states. When addressing strategies to prevent unwanted data transfers, the EU should draw lessons from its fragmented approach to Huawei's involvement in European 5G technology. While some member states imposed restrictions on Huawei's 5G equipment, others did not, creating inconsistencies that weakened the cybersecurity of the hyper-connected single market. National security imperatives should be aligned across the EU, fostering close collaboration among all stakeholders in the supply chain, including OEMs, suppliers, and technology providers.

PREVENTING SOCIAL AND POLITICAL INSTABILITY IN THE EU

EVs require fewer components than ICEs, with around 30 key components needed for an internal combustion engine powertrain compared to just 9 for a BEV powertrain.[104] The transition from ICEs to EVs thus implies an important reduction in the supplier network. While new jobs will be created in areas such as battery production, infrastructure, and digital technologies, including software, the transition has not progressed as anticipated. Recent estimates show that out of the projected 100,000 new jobs in EV supply chains by 2025, only 20% have materialized.[105] Other estimates suggest that by 2035 the transition to EVs could render over 500,000 jobs in the production of internal combustion engine powertrain components obsolete.[106] This risk is compounded by lower demand for EVs, competition from Chinese OEMs, and the extensive use of robotization, all of which accelerate potential job losses in the EU supplier network. Given the broad distribution of automotive employment across member states (Figure 1), these changes could have profound social and political consequences and must be anticipated. Without significant investment in reskilling and technology upgrades, many workers in the automotive industry risk being left behind.[107] In recent months, several OEMs and suppliers have announced plant closures and layoffs. These measures can generate important ripple effects from the loss of skilled jobs to diminished regional economic activity and increased social tensions.

Labor plays a crucial role in attracting FDI to the EV sector. When tied to specific requirements – such as employing local workers, supporting local suppliers, and facilitating technology transfers – foreign investments can significantly contribute to local employment, including within the broader EV supply chain. The recently launched 'Innovation Fund 2024 Call and Battery calls' highlights the European Commission's efforts to attract meaningful investments. To access the €1 billion in EU subsidies allocated for electric vehicle battery cell manufacturing projects, foreign investors must comply with technology transfer requirements.[108] Greater transparency and coordination among member states on FDI conditionalities, aiming to ensure technology transfer and boost European jobs, would avoid creating a backdoor for hosting simple assembly plants.

104 McKinsey (2021), Electromobility's impact on powertrain machinery.

105 CLEPA (2024), Employment tracker.

106 CLEPA (2021), Electric Vehicle Impact Assessment Report 2020-2040: A quantitative forecast of employment trends at automotive suppliers in Europe.

107 Please refer to the section on economic security in this report.

108 IF24 Battery call, 3 December 2024, 20.

VI. Policy options

As the European automotive industry adapts to ambitious carbon emission reduction targets, rising global competition, and increasing supply chain vulnerabilities, EU policies can play a critical role in supporting a balanced transition. These policies must address immediate challenges while laying the groundwork for long-term resilience and innovation.

This section explores a range of policy options designed to support the sector's transition, while aligning with the EU's strategic objectives. These options are organized across four key areas: regulatory frameworks, trade policy instruments, industrial incentives, and infrastructure investments. Each policy option is evaluated based on its rationale, advantages, and disadvantages.

Note that these options are not recommendations. They are neither exhaustive nor presented in order of priority, as several pathways may need to be pursued in tandem to achieve the desired outcomes. Neither the options nor their order reflect the preferences of the authors. Moreover, the list does not analyze the technicalities of each measure. With the European Commission's announcement of a Strategic Dialogue on the Future of the European Automotive Industry, this list is intended to serve as a guide for policy options that can provide a common ground for discussion. Any comprehensive EU automotive industry strategy must carefully assess the timing and sequencing of policy interventions, their implementation requirements, and their potential impacts.

1 • Regulatory Measures

1. 1. Increase regulatory coherence across the EU
1. 2. Decarbonisation targets 2035 and reduction of CO_2 emissions regulation
1. 3. Regulatory incentives for EV adoption
1. 4. Public awareness campaigns
1. 5. EU-wide framework for Autonomous and Automated Vehicles
1. 6. Minimum Taxation Directive for ICE Vehicles
1. 7. Revising Safety and Insurance Regulations to Promote Smaller Vehicles

2 • Trade Policy Instruments

2. 1. Negotiate new trade agreements and deepen existing agreements
2. 2. Accelerate the adoption and implementation of Critical Raw Material Agreements
2. 3. Deepen cooperation with Japan and South Korea on battery supply chains
2. 4. Trade Remedies and enforcement actions
2. 5. Tariffs on Chinese EV components and knock-down kits
2. 6. Price undertakings
2. 7. Voluntary Export Restraints
2. 8. Establish Conditions for Foreign Direct Investment in the EU
2. 9. Political arrangements with China against the weaponization of EV supply chains

3 • Industrial Policy Measures

3. 1. Consumer subsidies
3. 2. Decarbonizing corporate fleets
3. 3. Phase out fossil fuel subsidies
3. 4. Research and Development subsidies
3. 5. Direct subsidies for transforming SMEs in the lower-tier of the supply chain
3. 6. Support workforce transition
3. 7. Accounting for Lifecycle Carbon Content of EVs
3. 8. Local Content Requirements (LCRs)
3. 9. National security restrictions on connected vehicles
3. 10. Decarbonizing the existing fleet
3. 11. Standardised Residual Value Calculations for EVs
3. 12. Scaling and commercialization of battery technology
3. 13. Affordable EU EV Platform
3. 14. Production-Based Subsidies
3. 15. Unified EU Battery Manufacturing Support Scheme

4 • Infrastructure Measures

4. 1. Improve charging infrastructure and electricity grids
4. 2. Increase recycling of battery materials
4. 3. Hydrogen Refuelling Infrastructure

1 . Regulatory measures

– 1. 1. Increase regulatory coherence across the EU

Rationale: A lack of regulatory alignment across EU member states can lead to fragmentation, causing confusion for manufacturers and consumers, delaying investments, and creating inefficiencies in meeting decarbonization targets. Mixed signals from inconsistent regulations can further deter investment.

Measures: Establish an EU task force to coordinate policies across member states and serve as a one-stop shop within the Commission to align incentives, standards, and regulations with overarching EU policy goals. The task force should explicitly prioritize avoiding regulatory fragmentation, which has been linked to lower EV adoption rates. Develop EU-wide policy frameworks to accelerate the deployment of enabling conditions and ensure a more uniform approach to regulatory incentives across the Union. Conduct a comprehensive review of existing automotive regulations to identify redundancies and eliminate non-essential requirements, thereby reducing compliance costs and stimulating economic activity.

Advantages: Consistent regulations across the EU are crucial to ensure a smooth transition to decarbonized mobility. Regulatory coherence reduces compliance costs, attracts investments in EVs, and creates a predictable, stable policy environment across the EU. Greater alignment can accelerate the deployment of charging and grid infrastructure, addressing one of the key barriers to EV adoption. A recent study highlights the risks of policy fragmentation, revealing that diverging global policies have hindered innovation in clean technologies in the automotive sector.[109]

Disadvantages: Achieving regulatory coherence requires strong political will and effective supervision, with significant challenges in achieving consensus among member states due to differing levels of economic development, political priorities, and existing infrastructure. The process may take time and risks regulatory overreach, potentially resulting in overly stringent or misaligned regulations that stifle innovation or impose burdensome compliance requirements.

– 1. 2. Decarbonization targets for 2035 and of CO_2 emissions reduction regulation

Rationale: The 2035 decarbonization target is critical for aligning the automotive industry with the EU's broader climate goals, as outlined in the Green Deal. However, the rapid pace of decarbonization presents significant challenges for companies still heavily reliant on internal combustion engine technology.

Measure: Reassess the 2035 timeline for mandating zero-emission vehicles and revise CO_2 emissions reduction regulations, including the penalty framework, to better support the transition.

109 Dugoua, E., & Dumas, M. (2023) Global coordination challenges in the transition to clean technology: Lessons from automotive innovation.

Advantages: Slower-than-expected growth in EV sales in the EU market limits economies of scale and the ability to meet CO_2 targets. Recalibrating deadlines could give the industry more time to adapt to decarbonization goals while allowing the Commission and member states to coordinate support measures, ensuring a more orderly transition to EVs that reduces economic shocks to manufacturers and suppliers. Uneven infrastructure development and significant regional disparities in EV adoption currently make it difficult for all member states to meet the 2035 targets. The move could also boost political support for decarbonization efforts by placating stakeholders who view the targets as overly ambitious and disruptive to the transition. A market for ICEs will persist in regions where decarbonization advances at a slower pace. Europe could remain competitive in these markets; even as Chinese manufacturers sustain their presence through exports. Furthermore, as a crucial contributor to Europe's innovation ecosystem, the automotive sector could bolster its long-term competitiveness by redirecting funds earmarked for fines or collected through penalties towards investments, rather than setting them aside or paying them to administrations.

Disadvantages: Moving the targets could undermine the EU's credibility as a global leader in climate action, especially after having championed ambitious decarbonization timelines on the international stage. It would weaken the credibility of existing regulations and send mixed signals to markets and an industry that has already invested heavily in decarbonization. A recent OECD study highlights that increased climate policy uncertainty induces investment slowdowns across many industries.[110] Revising the deadline could thus not only slow down ongoing investment and innovation in clean technologies and hinder the long-term global competitiveness of the EU automotive industry, but also have negative spillover effects on other industries. Any delay or softening of regulations risks severely undermining the competitiveness of European manufacturers, especially as Chinese automakers push ahead aggressively in electrification. Without a clear and accelerated strategy for repurposing existing ICE plants, Europe could face production bottlenecks. Constant shifts in the regulatory approach to timelines also risk creating consumer confusion in the transition to zero-emission vehicles. Robust enabling measures — such as drawing on the supportive options outlined in this report — may be a more stable regulatory path for all market participants. Studies on zero-emission vehicle (ZEV) mandates in several US states show that such mandates – which require manufacturers to sell a minimum percentage of ZEVs – have increased the variety of EV models by 15–20% compared to scenarios relying solely on consumer subsidies. These mandates have also been found to significantly accelerate EV adoption rates.[111]

1. 3. Regulatory incentives to promote EV adoption

Rationale: Prioritizing incentives over restrictive measures is essential to strengthen and sustain demand for EVs and avoid political backlash, particularly in regions with large populations of lower-income consumers. Restrictive measures risk fueling populist movements opposed to EU policies.

110 Berestycki, C. et al. (2022) Measuring and assessing the effects of climate policy uncertainty.

111 Armitage, S. & Pinter, F. (2022), Regulatory mandates and Electric vehicle variety. Bedsworth, L. W., & Taylor, M. R. (2007) Learning from California's zero-emission vehicle program. Cole et al. (2023) Policies for electrifying the light-duty vehicle fleet in the United States.

Measure: Implement regulatory incentives for ZEVs and PHEVs to promote their adoption. Examples include low-emission zones, reduced registration fees, parking benefits, fast-track licensing, and geofencing for PHEVs. Establish EU-wide policy frameworks requiring member states to adopt EV-friendly regulations and ensure a more uniform approach to regulatory incentives across the EU. Leverage digital mobility management tools, such as a dynamic road charging system, to adjust fees based on vehicle emissions, time of day, and location. This system could reduce congestion, encourage off-peak travel, and reward the use of low-emission vehicles.

Advantages: Regulatory incentives have little to no direct fiscal impact, making them appealing to budget-constrained governments and more politically viable than direct subsidies or tax breaks. They can also foster a sense of urgency among both consumers and manufacturers, accelerating innovation and expediting the development and adoption of EVs. By linking mobility costs to environmental impact, dynamic road charging systems can incentivize the shift to cleaner transport options, such as EVs and public transit, and optimize the use of existing infrastructure.

Disadvantages: Measures such as zero-emission vehicle mandates risk public resistance, particularly if implemented hastily or without adequate public consultation, potentially triggering political backlash or legal challenges. Effective implementation requires complex coordination across different levels of government; if not managed properly, this could result in regulatory fragmentation, with some regions advancing faster than others. Additionally, for regulatory incentives to have a meaningful and uniform impact, they must be supported by robust communication campaigns to address consumer concerns about EV cost, range anxiety, and perceived charging complexity.

– 1. 4. Public awareness campaigns

Rationale: Increasing public awareness of the reliability, cost-effectiveness, and environmental benefits of transitioning from ICEs to EVs is essential to address consumer reluctance and concerns and assist in the transition.

Measure: Launch public awareness campaigns on traditional and social media platforms to emphasize cost savings of EVs over their life cycle, counter misinformation on charging accessibility, and promote EVs as a mainstream and sustainable alternative to ICEs. Promote the environmental benefits of top-rated energy-efficient tires. Limit vehicle advertising to zero-emission models.

Advantages: A well-designed and extensive campaign can encourage consumer acceptance of EVs, reinforcing demand across the EU and facilitating a smoother transition. Such initiatives also demonstrate political commitment to decarbonization.

Disadvantages: The high cost of an EU-wide campaign poses a major challenge. There is a risk of backfiring if the campaign fails to account for cultural differences or effectively target the right audience. Careful implementation is required to avoid public backlash, particularly in regions with insufficient EV infrastructure, where the campaign could be perceived as out of touch.

– 1. 5. EU-wide framework for autonomous and automated vehicles

Rationale: Europe lags behind the US and China in AAV development. Fragmentation in testing and deployment frameworks across member states stifles innovation and hinders global competitiveness.

Measures: Develop an EU-wide framework for testing AAV systems. Simplify procedures and harmonize requirements across member states to reduce costs and eliminate market fragmentation. Establish funding streams to support large-scale AAV testing programs, modelled on successful international initiatives, to attract investment and foster the development of EU champions. Adopt EU-wide standards for scenario-based AAV testing, aligned with international bodies (UNECE, CEN, ETSI, ISO), to ensure consistent safety benchmarks. Support pilot programs at the member state level that operate under common EU principles, allowing real-world testing to inform EU-wide frameworks. Expand projects like L3Pilot and ARCADE to test and validate technologies under diverse conditions, refine safety metrics, and accelerate market readiness. Promote investments in C-ITS and digital infrastructure to enable seamless interaction between AAVs, roads, traffic systems, and other vehicles.

Advantages: Accelerates innovation in autonomous technology, ensuring EU competitiveness in the global market. Encourages the development of scalable, cross-border AAV solutions rather than fragmented local systems.

Disadvantages: Requires significant coordination among member states and alignment with existing safety regulations.

– 1. 6. Minimum taxation directive for ICEs

Rationale: The uneven taxation of ICEs across EU member states creates opportunities for regulatory arbitrage and undermines the consistency of Europe's decarbonization efforts, presenting a critical challenge in the transition to EVs.

Measure: Adopt an EU directive – drawing inspiration from the Energy Taxation Directive – that sets a minimum tax floor for ICE purchases and corporate ownership. Member states would retain the flexibility to exceed this floor and adapt their tax structures to their national contexts, but would be prohibited from setting rates below the agreed-upon threshold.

Advantages: Reduces internal EU distortions and ensures that the cost of owning ICEs aligns more closely with the EU's climate goals. Strengthens the EU's decarbonization policies by complementing emissions regulations with financial disincentives for carbon-emitting vehicles.

Disa**dvantages:** May face political opposition or require prolonged negotiations among member states with divergent fiscal policies. Could increase costs for businesses still reliant on ICE fleets, raising competitiveness concerns if not paired with adequate support measures to facilitate the transition to EVs.

– 1. 7. Revising safety and insurance regulations to promote smaller vehicles

Rationale: Current safety regulations and insurance models disproportionately favor larger vehicles, resulting in higher premiums for smaller alternatives and hindering their adoption. Smaller vehicles offer significant environmental and economic benefits, particularly in urban areas, and are critical for reducing emissions and resource consumption. Revising these frameworks can level the playing field and encourage sustainable mobility choices.

Measure: Revise EU crash test protocols to accurately assess the safety performance of smaller vehicles, thereby mitigating the malus effect. Require insurance providers to adopt fair pricing structures that do not disproportionately penalize smaller vehicles. Introduce EU-wide incentives to encourage manufacturers to innovate and develop advanced safety technologies tailored for smaller vehicles.

Advantages: Encourages the production and adoption of smaller, more environmentally sustainable vehicles, particularly for urban use. Reduces barriers to market entry for small vehicle manufacturers, fostering innovation and competition. Supports urban mobility goals by making smaller vehicles more accessible and affordable.

Disadvantages: Revising safety regulations and crash test protocols may require significant time and resources, including cross-stakeholder collaboration. May negatively affect the competitiveness of EU manufacturers of larger vehicles.

2 • Trade policy instruments

– 2. 1. Negotiate new trade agreements and deepen existing agreements

Rationale: Diversifying export, consumer, and sourcing markets is vital to enhancing resilience, reducing dependencies, and ensuring long-term competitiveness.

Measure: Negotiate new trade agreements with relevant partners, expedite the conclusion of existing negotiations (e.g. Australia, India, Indonesia, Philippines, Thailand) and the ratification of the EU-Mercosur agreement. Improve the implementation and expansion of existing agreements. Consider long-term region-to-region agreements, such as partnerships with AfCFTA, ASEAN, and CPTPP, particularly focusing on diagonal cumulation of rules of origin. Explore alternative trading formats, such as sector-specific agreements, to overcome the protracted and complex nature of traditional bilateral or regional trade negotiations. Pursue greater regulatory cooperation with key trading partners, promote mutual recognition of standards, and develop international frameworks that streamline conformity assessments to reduce technical barriers to trade.

Advantages: Trade agreements provide market access by removing import quotas, local content requirements, and technical barriers that restrict access to high-growth markets. They foster positive political relations, trade, and investment dynamics. They also contribute to secure sourcing of inputs. The inclusion of sustainability standards can help to green EU and global supply chains. They also provide a mechanism to level the playing field in third markets vis-à-vis competitors that have preferential access via their own free trade agreements (FTAs).

Disadvantages: Trade agreements often require lengthy negotiations, frequently facing domestic political opposition and ratification hurdles. Sector-specific agreements would need to be designed to comply with WTO rules (GATT Art. XXIV) and avoid undermining the multilateral trading system, which serves as a critical legal framework for automotive supply chains.

– 2. 2. Accelerate the adoption and implementation of critical raw material agreements

Rationale: Securing a stable supply of critical raw materials and refined inputs is essential to safeguard EU industries from vulnerabilities associated with third-country supply chain dominance and mitigate risks of retaliatory measures amid escalating geopolitical tensions.

Measure: Strengthen and expand agreements under the Critical Raw Materials Act (April 2024) by prioritizing measures to ban export monopolies, establish frameworks for domestic/export dual pricing systems, and enforce transparency and non-discrimination in awarding mining concessions. Redirect funds from the Global Gateway initiative to secure critical raw materials. Accelerate project timelines to address urgent needs in battery and EV supply chains. Concurrently, invest in local refining capacity to maximize the effectiveness of these agreements. Take direct stakes in key foreign critical mineral projects through strategic partnerships to ensure sustainable sourcing and improved ESG compliance, supported by Global Gateway initiatives. Elevate ESG standards across the global minerals sector by expanding membership in the Minerals Security Partnership.

Advantages: Diversification enhances certainty of supply, reduces over-dependency, and aligns with the broader EU geopolitical agenda. Critical agreements should prioritize access to processing and refining technologies, areas where Europe currently lacks capacity and relies heavily on third countries, in particular China.

Disadvantages: The limited number of suppliers and the lengthy negotiation processes could slow diversification efforts. China's dominant position throughout the value chain restricts the EU's ability to reduce dependence in the short term. Potential environmental and social risks in resource-rich developing countries, coupled with competing climate and security goals, further complicate the implementation of agreements. Without parallel investments in domestic infrastructure or partnerships with other third countries to develop these capabilities, EU reliance on China for processing will persist. Additionally, critical raw material agreements alone cannot eliminate Europe's dependency on Chinese equipment and technological know-how, which are essential for refining processes.

– 2. 3. Deepen cooperation with Japan and South Korea on battery supply chains

Rationale: Diversifying supply chains within the battery sector is crucial for enhancing resilience and reducing vulnerabilities.

Measure: Negotiate new cooperation agreements with Japan and South Korea, focusing on joint R&D initiatives, investments in advanced recycling technologies, and collaboration on sustainable sourcing practices for battery materials. Establish mechanisms for technology and skills transfer through joint training programs and technology licensing agreements.

Advantages: Cooperating with Japanese and South Korean firms provides the EU with access to cutting-edge expertise and technology, accelerating the development of a competitive European battery industry.

Disadvantages: Collaboration risks intensifying competition among European, Japanese, and South Korean battery manufacturers. Intellectual property concerns may arise, particularly around the sharing of sensitive European technologies with foreign partners. Additionally, as Japan and South Korea also rely on imported critical raw materials, such partnerships may have a limited impact on reducing the EU's reliance on CRMs from China.

– 2. 4. Trade remedies and enforcement actions

Rationale: Ensuring a competitive level playing field is essential to protect the EU automotive industry against unfair trade practices and surges in imports. This is particularly relevant for imports from countries like Turkey and Morocco, which benefit from duty-free access to the single market under agreements such as the Customs Union and the Deep and Comprehensive Free Trade Area.

Measure: Enforce robust trade remedy instruments, including the Foreign Subsidies Regulation, anti-dumping measures, countervailing duties, and safeguards, potentially in collaboration with EU allies. Establish EU-wide verification mechanisms to assess the composition and compliance of imported automotive components with EU standards, such as REACH, ensuring fair competition and adherence to EU norms. Implement safeguard measures or price undertaking agreements for battery cells, allowing a limited volume of imports at reduced tariffs while maintaining higher tariffs on others to encourage local investment.

Advantages: These measures align with WTO rules, support intelligence-gathering on exporters, and ensure coherence with the EU's economic security strategy. They provide market certainty to foster local investment while protecting EU industries from unfair trade practices.

Disadvantages: The implementation process can be time-consuming, requiring detailed investigations. These measures may strain relationships with exporters, potentially triggering retaliatory actions or escalating trade conflicts. Poorly calibrated quotas could disrupt supply chains. Empirical studies suggest that anti-dumping duties are only effective when the risks of retaliation or tariff-jumping are low.[112] Additionally, such actions may generate negative spillover effects along fragmented value chains.

– 2. 5. Tariffs on Chinese EV components and knock-down kits

Rationale: Prevent circumvention of trade remedies on Completely Built Units (CBUs) through assembly plants in the EU.

Measure: Increase tariffs or introduce targeted trade remedies on components.

112 Blonigen, B. A., & Prusa, T. J. (2016), Dumping and antidumping duties. Blonigen, B. A., & Bown, C. P. (2003), Antidumping and retaliation threats. Bown et al. (2021), Trade protection along supply chains. Grossman et al. (2024) When tariffs disrupt global supply chains.

Advantages: Strengthens the local components industry and bolsters the broader automotive sector. Higher tariffs could accelerate the localization efforts of Chinese manufacturers, potentially prompting them to produce components or even assemble complete vehicles within Europe to avoid tariffs.

Disadvantages: Higher tariffs increase production costs and carry a risk of circumvention through third countries such as Morocco or Turkey. They may negatively impact innovation and global competitiveness. Chinese FDI in Europe could have unintended consequences, such as strengthening the market presence of Chinese firms and increasing competitive pressure on European firms. Tariffs alone may not be enough to offset the price advantages enjoyed by Chinese manufacturers, which benefit from subsidies (direct grants, tax breaks, and loans), scale, and efficiency. Higher tariffs could also encourage deeper vertical integration within Chinese firms operating in the EU. Additional tariffs on imported battery cells or materials could hinder efforts to meet decarbonization targets. The EU's significant reliance on China makes it highly vulnerable to retaliation. Smaller suppliers, who are less capable of absorbing price increases, would face disproportionate challenges. Enforcement actions (see above) may offer a more effective and calibrated approach to addressing circumvention of countervailing duties on Chinese EVs.

– 2. 6. Price undertakings

Rationale: Negotiated protection and agreement with exporting countries.

Measure: Implement minimum import prices; possible quantitative import restrictions.

Advantages: Minimizes trade conflicts with exporting countries, adheres to WTO rules, and creates certainty in competitive pricing. Can also serve as a negotiation tool to maintain diplomatic relations while providing limited but effective protection to EU producers.

Disadvantages: Feasible only within the framework of countervailing duty or anti-dumping investigations and may be less effective than duties. Enforcement is challenging and prone to circumvention. Furthermore, such measures may fall short unless complemented by strategies to scale up domestic production and reduce costs to ensure global competitiveness.

– 2. 7. Voluntary export restraints

Rationale: Voluntary export restraints (VERs) provide a mechanism to prevent Chinese EVs from overwhelming the EU automotive market.

Measure: Implement VERs to cap the number of imported CBUs or CKD EVs from China. Ensure transparency by communicating the temporary nature of these restrictions and establish clear timelines for their removal to avoid long-term market distortions.

Advantages: Shields the European automotive industry from a sudden influx of competition, providing a buffer period to adapt. Incentivizes Chinese manufacturers to invest in local production facilities within the EU. Historical precedents, such as the VERs imposed on Japanese automobile exports to the US during the 1980s, demonstrate the potential for significant inflows of FDI.[113]

Disadvantages: Could lead to unintended market distortions and potential breaches of WTO rules, harming the EU's reputation and undermining the rules-based trading system. May provoke Chinese retaliation. Previous VERs on automobiles have been shown to increase consumer prices, potentially dampening EV demand and slowing their adoption.[114]

– 2.8. Establish conditions for foreign direct investment in the EU

Rationale: Establishing clear conditions for FDI in the EU is essential to ensure that new investments contribute to local supplier networks and strengthen the EU's industrial ecosystem.

Measures: Establish FDI conditionality requiring joint ventures with local suppliers and offering R&D incentives, such as tax breaks for foreign companies investing in R&D or setting up local training programs. Include safeguards for vehicle connectivity systems and data collection, with harmonized security standards. Under the 'balance test' rules of the Foreign Direct Investment Screening Regulation, prioritize local IP creation, value addition, and skill development when evaluating incoming investments. Introduce anti-circumvention rules mandating that at least 40–50% of EV value is sourced within the EU. Expand the EU FDI Screening Regulation to include greenfield investments with coherent screening criteria across member states.

Advantages: Promotes value creation within the EU by fostering a network of suppliers, driving innovation, and guaranteeing that main parts and components are produced domestically. Enhances EU competitiveness by creating high-value jobs. Aligns with WTO rules while remaining open to foreign investment under defined conditions, even as countervailing measures are applied. Encourages joint ventures, fast-tracking the transfer of critical knowledge and capabilities from established global players to EU manufacturers, particularly in battery production and recycling technologies.

Disadvantages: Achieving consensus among member states to coordinate foreign investment policies or expand the EU FDI Screening Regulation to cover greenfield investments may be a lengthy process. While these measures could reduce dependency on imported batteries, they may fail to address reliance on imported refined critical minerals unless the EU simultaneously invests in refining capacity. Advanced EV technologies may heighten cybersecurity and privacy risks if member states do not establish unified regulatory oversight.

113 Berry, S., Levinsohn, J., & Pakes, A. (1999) Voluntary export restraints on automobiles: Evaluating a trade policy.

114 Ibid.

– 2. 9. Political arrangements with China to prevent the weaponization of EV supply chains

Rationale: Ensuring stability in the EV industry's critical input supply chains is essential to safeguard against potential geopolitical tensions with China, which has previously leveraged its dominance in key sectors for strategic advantage.

Measure: Negotiate specific arrangements with China that link market access commitments to enforceable assurances against the weaponization of battery and critical input supply chains. These arrangements should mandate transparency in supply chain operations and guarantee uninterrupted access to critical materials.

Advantages: Avoids disruption in supply of essential inputs and materials. Opens avenues for positive engagement, including joint projects, and avoids a zero-sum dynamic in trade relations. Establishes a framework for trust-building that could extend to other sectors, potentially de-escalating geopolitical tensions. Leverages the EU's position as China's largest and most lucrative export market for EVs (especially at a time of cut-throat competition within China's domestic market), providing significant bargaining power.

Disadvantages: Negotiations may be protracted and require significant concessions, with a risk of non-compliance from China despite formal agreements. Strengthening ties with China in EV supply chains could weaken broader EU efforts to decouple and diversify. Companies may remain reliant on Chinese technology without gaining meaningful independent expertise.

3 • Industrial policy measures

– 3.1. Consumer subsidies

Rationale: Reducing the higher upfront costs of EVs is crucial to making them accessible, especially for middle-income consumers who might otherwise be priced out of the market. Subsidies play a role in boosting EV demand and promoting a socially equitable transition to electric mobility.

Measure: Implement targeted consumer subsidies based on income levels or linked to vehicle energy efficiency. Expand support mechanisms to include subsidies for second-hand EVs and low-interest loans, ensuring inclusivity. Coordinate subsidies at the EU level to minimize disparities between member states and prevent market distortions. Complement these efforts with tax incentives, rebates, or zero-interest loan programs.

Advantages: Eases financial barriers for consumers, accelerating EV adoption and directly supporting the EU's decarbonization goals. More EVs on the road would contribute to. stimulate demand for charging infrastructure and other related services and creating a virtuous circle of growth. Subsidies align with WTO rules and improve affordability, helping OEMs achieve economies of scale and reduce production costs. Surveys in Norway and the US confirm that high purchase prices are a major barrier to EV adoption, and studies show that subsidies with high pass-through rates substantially increase uptake (Egbue et al. 2012, Mersky et al. 2016, Aasness et al. 2015, Bjerkan et al. 2016).[115]

Disadvantages: Subsidy programs can strain public finances, requiring large outlays that may face political opposition or become unsustainable over time as EV adoption rises. Poorly targeted subsidies risk disproportionately benefiting wealthier consumers, inviting criticism that such subsidies are regressive rather than progressive. Subsidizing new EVs may inadvertently depress the resale value of used EVs, which can be problematic for the premium segment, and lead to financial losses for leasing companies and individual buyers. Empirical studies highlight the importance of well-designed subsidies, as attribute-based policies may distort competition, reducing pass-through efficiency and adversely impacting adoption rates (Barwick et al. 2024, Remmy 2023).[116]

– 3. 2. Decarbonizing corporate fleets

Rationale: Corporate fleets account for a significant share of new vehicle sales in the EU. Transitioning these fleets to EVs can amplify the impact on emissions reductions while familiarizing a broad base of drivers to electric mobility.

Measure: Introduce tax incentives for corporate car fleets, including tax deductions tied to electrification targets, direct tax credits for transitioning a specified percentage of fleets to EVs, and incentives for investments in charging infrastructure. Offer targeted support to leasing companies, enabling SMEs to adopt EVs through flexible and affordable leasing options. Phase out existing incentives for large petrol and diesel vehicles.[117]

Advantages: Boosts demand and familiarizes drivers with EVs. Offers straightforward implementation and accelerates fleet-wide emissions reductions. Supports economies of scale for EV production and creates consistent, predictable demand for manufacturers. The effectiveness of these measures, however, depends on the careful design of tax incentives.[118]

Disadvantages: Fleet operators may resist due to the significant upfront investments required, especially in the absence of compelling financial incentives. High corporate uptake may reduce public tax revenues. The policy's impact may be uneven across industries; for example, sectors like logistics may benefit more than others, potentially limiting overall effectiveness. Bureaucratic inefficiencies in implementing tax incentives could erode their effectiveness and deter adoption.

115 Egbue, O., & Long, S. (2012) 'Barriers to widespread adoption of electric vehicles: An analysis of consumer attitudes and perceptions.' Mersky, A. et al. (2016). 'Effectiveness of incentives on electric vehicle adoption in Norway.' Aasness, M. A., & Odeck, J. (2015) 'The increase of electric vehicle usage in Norway—incentives and adverse effects.' Bjerkan et al. (2016) 'Incentives for promoting battery electric vehicle (BEV) adoption in Norway.'

116 Barwick et al. (2024) 'Attribute-based subsidies and market power: an application to electric vehicles'. Remmy, K. (2022). 'Adjustable product attributes, indirect network effects, and subsidy design: The case of electric vehicles.'

117 Fossil fuel subsidies for company cars cost EU taxpayers €42 billion every year. Dalder, J. et al (2024) 'Company car fossil fuel subsidies in Europe.'

118 Barwick et al. (2024), Remmy (2023).

3. 3. Phase out fossil fuel subsidies

Rationale: Fossil fuel subsidies encourage the production and consumption of high-emission combustibles.[119] They distort prices, generate inefficiencies in energy use, and conflict with the EU's transition to EVs and broader climate goals.[120]

Measure: Accelerate the phase-out of subsidies for crude oil and refined products, including diesel, gasoline, and kerosene, in line with the EU's 2023 COP28 pledge to eliminate fossil fuel subsidies globally.[121]

Advantages: Frees up resources to support the transition to net-zero emissions and stimulates innovation in energy efficiency, while reducing distortions in energy markets.

Disadvantages: Phasing out fossil fuel subsidies could increase the cost of combustibles that remain essential during the transition to EVs, potentially exacerbating social inequalities and sparking protest movements.

3. 4. R&D subsidies

Rationale: Strengthening EU R&D efforts is crucial to improve the global competitiveness of its automotive supply chains and lower critical dependencies in areas like battery technology, hydrogen fuel cells, and autonomous driving. With China and the US making significant strides in these fields, the EU must continue to accelerate its innovation agenda to ensure long-term industrial competitiveness.

Measures: Increase funding for R&D in critical areas such as white hydrogen extraction, autonomous driving, and battery development, targeting both incremental improvements in current battery chemistry and breakthroughs in next-generation technologies like solid-state batteries. Prioritize the development of alternative materials and recycling technologies to reduce dependency on critical raw materials. Include funding for skills development programs and engineering education focused on battery technology and automotive software. Provide R&D subsidies for SMEs and mature start-ups involved in electromobility and critical supply chains. Streamline Horizon Europe's administrative processes to reduce red tape and position electromobility as a core pillar. Simplify subsidy application and approval processes under the EU Innovation Fund to provide clear and predictable funding mechanisms. Strengthen initiatives bridging R&D and industrialization, such as through the EU Innovation Fund or Important Projects of Common European Interest (IPCEI).

119 Fossil fuel subsidies take different forms, including explicit measures such as government spending that artificially lowers the price of fossil fuels for consumers, direct price controls, tax breaks for fossil fuel producers, and government funding to cover the operating costs of fossil fuel power plants. According to the European Environment Agency, fossil fuel subsidies in the EU remained relatively stable at about €56 billion (2022 prices) between 2015 and 2021. However, they surged to €123 billion in 2022 due to the post-Covid economic recovery and the impact of Russia's invasion of Ukraine. European Environment Agency (2023) 'Fossil Fuel Subsidies.'

120 OECD (2024) 'OECD inventory of support measures for fossil fuel 2024.'

121 On 17 October 2024, the European Commission issued guidance (C/2024/7161) clarifying the requirement under Article 17(15) to discontinue, by 1 January 2025 at the latest, any financial incentives for installing building heating systems powered by fossil fuels.

Advantages: Improves industry competitiveness and drives technological breakthroughs. Promotes job creation in high-tech sectors, aligning with green and digital transitions while fostering expertise in future-oriented technologies. Spurs innovation that strengthens the EU's position as a global leader in automotive exports, particularly in emerging markets where demand for EVs is expected to grow. Targeted support for SMEs fosters innovation and strengthens the broader industrial ecosystem. Simplifying Horizon Europe processes improves accessibility for smaller players, ensuring a more equitable distribution of funding.

Disadvantages: Fiscal constraints make sustaining R&D subsidies challenging amid competing economic priorities across the EU. Long lead times for returns on investment can create political pressure to deliver immediate results. There is a risk of public funds being directed towards R&D initiatives that fail to achieve commercial viability and to have a market impact. Empirical evidence suggests that intensive public investment subsidies can crowd out private investment, particularly from large firms (Lach 2002). Studies also find that while such subsidies may have a limited positive impact on employment and productivity for small firms, they often yield minimal benefits for larger companies (Cerqua at al. 2014, Criscuolo et al. 2019).

– 3. 5. Direct subsidies for transforming SMEs in the lower tier of the supply chain

Rationale: SMEs constitute a vital part of the EU's automotive supply chain but often lack the financial resources to transition from ICE-focused operations to zero-emission technologies. These businesses are highly susceptible to cost pressures and many risk going out of business, particularly in economically vulnerable regions. Supporting their transformation is essential for maintaining a resilient, competitive supply chain and mitigating the localized social and political fallout of the transition.

Measure: Develop a subsidies program providing targeted grants or low-interest loans to SMEs investing in zero-emission technologies or workforce reskilling. Introduce sector-specific subsidies for SMEs contributing to key areas such as the battery supply chain or software development – modelled on the Domestic Manufacturing Conversion Grants in the US, which directly support the transformation of existing plants. Link these subsidies to the Social Climate Fund, cohesion funds, and other regional programs to ensure that resources reach economically and infrastructurally challenged regions. Promote consolidation among smaller firms to realign supply chains with market demands and enhance long-term competitiveness.

Advantages: Ensures the local availability of critical inputs and enables SMEs dependent on ICE production to transition to emerging technologies. Strengthens the resilience of the EU supply chain and ensures a socially inclusive and regionally equitable shift to EV production.

Disadvantages: High levels of participation could strain budgets, posing fiscal challenges for subsidy programs. Effective management requires clear eligibility criteria, robust monitoring of fund usage, and mechanisms to track outcomes, potentially increasing administrative complexity and delays.

– 3. 6. Support workforce transition

Rationale: The transition to EV production will profoundly impact the workforce, especially in traditional ICE manufacturing sectors, posing risks of significant job losses. To ensure industry stability, large-scale interventions are required to help workers adapt to new technologies like battery manufacturing and vehicle software through targeted upskilling and reskilling initiatives.

Measures: Implement an EU-wide reskilling and upskilling program, funded through the Social Climate Fund, to equip the automotive workforce for green and digital transformations. Prioritize regions and industries disproportionately affected by the transition, creating dedicated training centers in collaboration with member states. Incorporate criteria favoring EVs manufactured in the EU with cleaner energy mixes, drawing inspiration from successful initiatives like France's social leasing program. Develop an EU-wide program modelled on the SURE initiative to provide targeted financial support to the automotive sector, with a focus on worker retention.

Advantages: Upskilling the workforce reduces the risk of widespread job losses and ensures a smoother transition, particularly in regions heavily reliant on traditional automotive manufacturing. Promotes social and political stability during the transition. Fosters a more adaptable and innovative workforce, enhancing the EU's global competitiveness in an increasingly high-tech automotive market.

Disadvantages: Training programs require significant investment of time and resources, potentially straining government and corporate budgets. Retraining older workers or those with limited technical skills may be challenging and lead to unequal outcomes. Coordination of reskilling efforts across diverse labor markets and industrial structures within the EU may prove difficult.

– 3. 7. Accounting for life cycle carbon content of EVs

Rationale: Establishing sustainability requirements can promote battery production within the EU.

Measure: Ahead of the 2027 launch of the EU battery passport – which will track a battery's life cycle, carbon footprint, resource efficiency, and end-of-life management – the EU must establish a standardized methodology for measuring the carbon footprint. The methodology should evaluate whether market entry will require meeting a defined carbon threshold. Potential approaches include assessing the carbon emissions of the producing country's energy grid or incorporating power purchase agreements between battery producers and renewable energy providers to measure the CO_2 footprint of production.

Advantages: Supports the reshoring of battery manufacturing and technological know-how, directly benefiting European producers. Including transport emissions in carbon footprint assessments could further incentivize the use of domestically produced batteries.[122] Additionally, it may prevent a reshuffling of the carbon energy mix in exporting countries.

122 Leichthammer, A. (2024). 'Welcoming Chinese FDI with open arms—and a clenched fist.' Policy Brief, Jacques Delors Center.

Disadvantages: These measures could disincentivize producers from fully decarbonizing their supply chains and drive-up battery costs. Europe's limited refining capacity – e.g. accounting for only 5–10% of its Nickel needs – significantly hampers its ability to achieve autonomy in battery manufacturing. Fragmented policies among member states risk undermining the single market, creating inconsistencies and barriers to the efficient rollout of EV technologies across the EU.

– 3. 8. Local content requirements (LCRs)

Rationale: Strengthen and establish a local production ecosystem of suppliers while discouraging investment in low-value-added assembly factories, using imported parts.

Measure: Incorporate local content requirements into investment and subsidy regulations.

Advantages: Stimulates local manufacturing and job creation, reduces dependence on foreign suppliers, and mitigates supply chain disruption risks. Strengthens economic resilience and fosters the growth of domestic industries. Levels the playing field with trading partners that frequently apply LCRs.

Disadvantages: LCRs can be perceived as protectionist, potentially escalating trade tensions with global partners. They may hinder innovation by limiting access to cutting-edge technologies and could increase production costs, reducing competitiveness. Implementation and enforcement are complex and administratively burdensome. Studies find that stricter content requirements in the USMCA are ineffective in raising regional part production or employment, as moderate increases in local sourcing are wiped out by reduced overall assembly due to higher costs. Compliance with WTO rules is uncertain and depends on design specifics, potentially undermining the rules-based international order (Head et al. 2024). LCRs may result in superficial compliance with minimal genuine value addition in the EU in the absence of accompanying measures to reach technological parity or leadership. LCRs may not be fully enforceable due to loopholes such as blending and ambiguities in material origin definitions.

– 3. 9. National security restrictions on connected vehicles

Rationale: Mitigate risks related to the foreign capture and misuse of sensitive data within the EU.

Measure: Impose restrictions on the imports of Vehicle Connectivity System (VCS) Automated Driving Systems (ADS) hardware and software.[123]

Advantages: Strengthens EU-US security cooperation and fosters the development of hardware and software components for software-defined vehicles in the EU and partner countries. Creates a competitive advantage for EU and US markets over Chinese OEMs.

123 In September 2024, the U.S. Department of Commerce proposed regulations to prohibit the sale or import of connected and autonomous vehicles equipped with software or hardware from 'countries of concern,' notably China and Russia. The initiative aims to mitigate national security risks, including espionage and cybersecurity threats, associated with foreign technologies in vehicles operating on American roads.

Disadvantages: Higher costs for establishing 'secure' value chains could hinder EV adoption, especially given that EVs require twice the semiconductor content of ICEs (BCG 2022). Risks retaliation from trade partners and sets a precedent for applying national security restrictions to other sectors, which could be classified as dual-use under a security-focused interpretation. Escalation could lead to a complete ban on CBUs and CKD imports from China, undermining the EU's medium- to long-term competitiveness. Less invasive alternatives to outright bans might achieve national security objectives while balancing economic interests. Overreaching restrictions could create unnecessary trade barriers, stifle competitiveness, and deter innovation in connected and automated vehicle technologies.

– 3.10. Decarbonizing the existing fleet

Rationale: Addressing the emissions from the current fleet is critical to achieving meaningful decarbonization, as focusing solely on new vehicle sales overlooks the substantial impact of vehicles already on the road.

Measures: Introduce financial incentives for retrofitting existing vehicles with low-emission technologies, such as hybrid systems or hydrogen fuel cells. Develop scrappage schemes targeting the most polluting vehicles, tied to subsidies for purchasing cleaner alternatives. Support the deployment and affordability of e-fuels for existing ICEs to provide an immediate emissions reduction pathway.

Advantages: Delivers emissions reductions in the largest segment of active vehicles, achieving faster results. Engages consumers who are not planning to purchase new cars. Extends the lifespan of existing ICEs while reducing emissions, particularly benefiting hard-to-electrify segments like heavy-duty or vintage vehicles. Provides a transitional solution that complements other long-term decarbonization strategies.

Disadvantages: Requires careful implementation to prevent waste and fraud in scrappage and retrofit schemes. E-fuel production is energy-intensive and expensive, requiring substantial investment in renewable energy to achieve net-zero emissions. Could slow the transition to zero-emission vehicles if e-fuels are perceived as a substitute rather than a complementary solution.

– 3. 11. Standardized residual value calculations for EVs

Rationale: Consumer uncertainty about EV resale values is a significant barrier to adoption. Establishing standardized calculation methods, similar to those for ICEs, can bolster consumer confidence.

Measure: Develop EU-wide standards for calculating EV residual values in collaboration with OEMs, financial institutions, and leasing companies, ensuring consistency and transparency in resale valuations.

Advantages: Boosts consumer trust in EV ownership, supports the growth of leasing markets, and stabilizes second-hand EV prices.

Disadvantages: Implementation complexity due to the need for stakeholder consensus. Requires alignment with different national tax and depreciation policies across the EU.

3. 12. Scaling and commercialization of battery technology

Rationale: Achieving cost-competitive battery production requires the EU to balance scaling and commercialization with ongoing R&D efforts.

Measure: Expand the ETS Innovation Fund and introduce operational expenditure (OpEx) auctions for battery cell production with EUR-per-kWh incentives tied to production volume.[124] Simplify state aid rules for ex-ante approvals under the Net-Zero Industry Act. Focus on production-based subsidies and offer top-ups for projects that source materials locally.

Advantages: Drives large-scale production, reduces costs, and strengthens EU competitiveness in battery and component manufacturing.

Disadvantages: Requires significant public funds and rigorous oversight to ensure effective implementation. Subsidies tied to domestic over imported goods are prohibited under Article 3.1(b) of the WTO Agreement on Subsidies and Countervailing Measures.

3. 13. Affordable EU EV platform

Rationale: A pan-EU approach to affordable EVs can help member states implement social leasing schemes modelled on France's successful program.

Measure: Launch an Affordable EU EV Platform to aggregate demand for small, environmentally friendly, EU-made models. Offer templates for social leasing policies and use revenues from the Social Climate Fund and the EU's new emissions trading system (ETS2) to finance deployment.

Advantages: Improves EV accessibility for lower-income consumers and smaller member states. Encourages the purchase of EU-produced vehicles.

Disadvantages: Requires alignment across member states and consistent funding to sustain the platform.

3. 14. Production-based subsidies

Rationale: Provide direct incentives for scaling EV output.

Measure: Introduce output-based subsidies for OEMs tied to EV production volumes, such as subsidies per kWh of battery capacity produced or per EV unit manufactured, similar to models under the US Inflation Reduction Act.

124 Over the past six years, the European Investment Bank (EIB) has provided €6 billion to support the battery value chain, including raw materials, research, production, charging infrastructure, and recycling. On 3 December 2024, the EU Innovation Fund and the EIB announced a new partnership, allocating an additional €3 billion in public support to foster a competitive and sustainable European battery industry. By comparison, the US Bipartisan Infrastructure Act of 2021 allocated $7 billion to strengthen the US battery supply chain, and the tax incentives of the Inflation Reduction Act (2022) spurred over $35 billion of private investment committed to new manufacturing capacity for zero emission vehicles, batteries, and critical minerals within the first year of its implementation.

Advantages: Encourages OEMs to ramp up EV production, making models more affordable and accelerating market penetration.

Disadvantages: High fiscal burden. Requires careful monitoring to prevent misuse.

– 3. 15. Unified EU battery manufacturing support scheme

Rationale: Current fragmentation in EU battery manufacturing incentives creates uncertainty for investors and limits scalability. A single EU-level system could streamline funding and provide clarity for investors, while fostering collaboration among key automotive nations.

Measure: Establish a federal-level EU scheme to support battery manufacturing, modelled on successful frameworks like 'auction as a service' used for hydrogen. The scheme could operate through enhanced cooperation among key automotive countries, such as Germany, France, Italy, Spain, and Slovakia, even if full unanimity is not achieved.

Advantages: Reduces fragmentation and offers investment certainty. Encourages economies of scale in battery production, strengthening Europe's competitiveness in the global market. Provides a unified platform for collaboration across major automotive nations.

Disadvantages: Requires political consensus and coordination among key member states. Potential resistance from non-participating member states or regions. High upfront costs for setting up an EU mechanism.

4 • Infrastructure measures

– 4. 1. Improve charging infrastructure and electricity grids

Rationale: Catalyze widespread EV adoption by addressing the uneven distribution of charging infrastructure across the EU and upgrading electricity grids to meet the demands of widespread EV use. Improving charging networks could also reduce reliance on large, costly batteries, lowering EV prices and increasing affordability. Upgrading electricity grid infrastructure is just as important as expanding charging networks, as grid readiness is crucial for scaling EV adoption.[125]

Measures: Expand the network of charging stations across Europe and coordinate national plans. Incentivize OEMs to increase their investments in charging infrastructure while significantly increasing public investment in electricity grids and renewable energy to lower energy prices. Standardize charging infrastructure for features like bidirectional charging (vehicle-to-grid) and interoperability of payment systems (e.g. Plug & Charge). Establish transparent, standardized charging tariffs per kWh, provide real-time price updates, and ensure clear communication of final costs to consumers. Introduce incentives for managed charging, offering rebates during periods of renewable energy abundance, such as high wind generation, to optimize grid usage and enhance cost-effectiveness for consumers.

125 Transport & Environment. (2024). Financing transport decarbonisation Study on investments for sustainable transport in the EU.

Reward customers for participating in vehicle-to-grid (V2G) systems, where EVs can return energy to the grid. Subsidize the installation of home solar systems paired with EV charging, drawing on successful models like Germany's incentive program. Develop specific charging targets for e-vans and trailers to ensure appropriate infrastructure for light commercial vehicles, particularly in logistics and transport sectors. Develop an EU program modelled on the Connecting Europe Facility to support charging infrastructure for transport corridors and e-logistics hubs. Implement provisions in the EU Action Plan for Grids to include EV integration in grid operator plans, standardize grid connection processes, and digitalize approval procedures across the EU. Strengthen funding from the alternative fuels infrastructure facility (AFIF) to ensure continued deployment of public charging and grid connections beyond 2025. Simplify and standardize the permitting process across member states to expedite the installation of charging infrastructure. Ensure timely grid access and sufficient power availability through close coordination with grid operators and policymakers. Promote competition by limiting exclusivity clauses, improving public tender processes, and addressing market power imbalances between operators of charging stations and mobility service providers.

Advantages: Boosts consumer confidence by reducing range anxiety and demonstrating political resolve for decarbonization. Increased EV sales strengthen the global competitiveness of EU firms in the EV market. Over the long term, reduced oil dependency improves EU energy security, while lower electricity prices make EVs more cost-effective for consumers. Integrating EV charging with renewable energy sources, such as managed charging during periods of wind or solar abundance, directly reduces the carbon intensity of transportation. By aligning incentives with renewable energy availability, EVs can become a key driver for decarbonizing both transport and energy sectors. Increasing the number of charging stations has emerged in economic literature as one of the most effective tools for increasing EV demand. Studies from Norway, the US, and Germany indicate that infrastructure subsidy schemes increased EV sales by 5% to 13% and were about 1.6 times more effective than direct consumer subsidies. This is because the subsidies are passed through directly to lower charging costs for consumers.[126]

Disadvantages: Imposes a significant fiscal burden on both national and EU budgets to fund widespread infrastructure improvements. Inefficiencies in implementation, such as uneven deployment across member states, may lead to regional disparities, delaying the realization of benefits in some regions while others advance more rapidly.

4. 2. Increase recycling of battery materials

Rationale: Growing environmental and geopolitical pressures are driving the need to reduce dependency on raw material imports. Recycling can contribute to strategic autonomy by lowering the reliance on foreign sources of critical materials.

126 Li et al. (2017), 'The market for electric vehicles: indirect network effects and policy design.' Springel, K. (2021), 'Network externality and subsidy structure in two-sided markets: Evidence from electric vehicle incentives.' Remmy, K. (2022), 'Adjustable product attributes, indirect network effects, and subsidy design: The case of electric vehicles.' Cole et al. (2023) 'Policies for electrifying the light-duty vehicle fleet in the United States.'

Measure: Hazardous classification of black mass.[127] Scale up incentives for advanced processing facilities to create a circular economy for battery materials within the EU through measures such as subsidies, tax incentives, and public-private partnerships. Incorporate battery material recycling into R&D priorities, with specific support for scaling advanced recycling technologies to industrial levels.

Advantages: Reduces the EU's exposure to geopolitical risks and strengthens supply chain resilience against potential disruptions. Offers potential environmental benefits, such as reducing the carbon footprint of mining and material extraction processes, which aligns with the EU's climate goals.

Disadvantages: Scaling up recycling technologies presents significant challenges, requiring substantial investments to bring recycling capacities to an industrial scale. Recycling initiatives may take a long time to meaningfully impact battery supply chains. Environmental risks and public opposition in local communities could hinder the establishment of new facilities. Recycling quotas may hinder EV adoption or lead to higher costs during the transition phase.

– 4. 3. Hydrogen refueling infrastructure

Rationale: Hydrogen has potential in Europe as an alternative zero-emission vehicle drivetrain for passenger cars, light commercial vehicles, and heavy-duty vehicles. However, an important barrier to its adoption is the underdeveloped hydrogen refueling infrastructure, with considerable disparities across regions.

Measures: Implement the hydrogen refueling targets set by the Alternative Fuels Infrastructure Regulation (AFIR), backed by appropriate de-risking mechanisms to support rollout. Strengthen EU funding for hydrogen infrastructure development and provide incentives to encourage investment in hydrogen mobility technologies.

Advantages: Expands the range of zero-emission drivetrain options and strengthens European capabilities in hydrogen mobility.

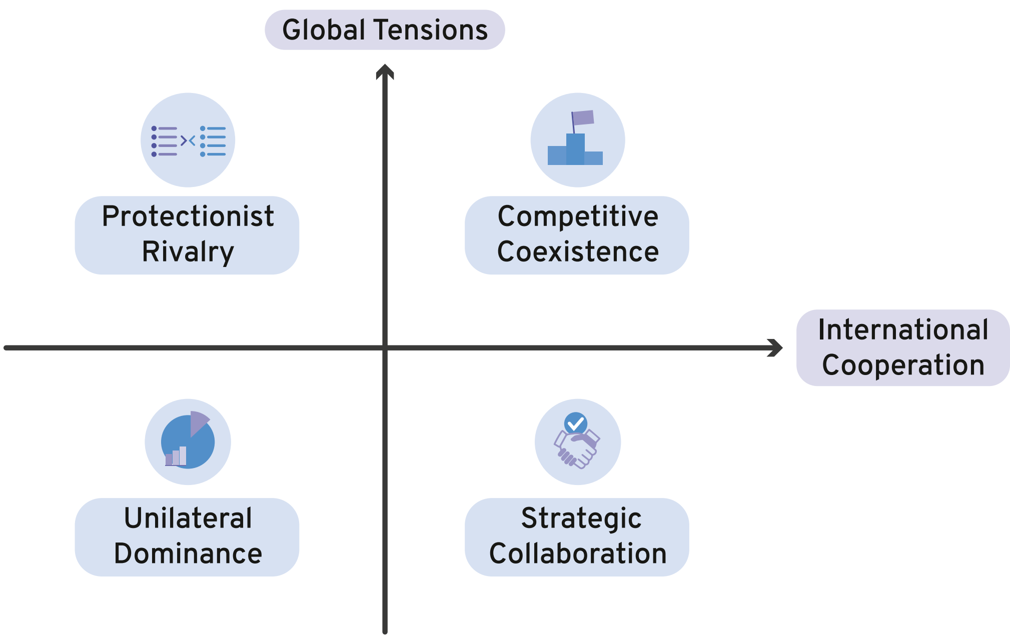
Disadvantages: Significant upfront investment is required, and disparities in adoption rates across regions may persist without comprehensive implementation.

127 Black mass is a material produced during the recycling of lithium-ion batteries. It consists of a powdered mixture of valuable metals, including lithium, cobalt, nickel, and manganese. In the EU, the classification of black mass remains inconsistent, with some member states designating it as hazardous waste while others do not, resulting in a fragmented regulatory landscape.

VII. Scenarios

The future of the automotive industry will be largely shaped by the level of global tensions and barriers, on one hand, and by the level of international cooperation in EV and battery value chains, as well as the competitive dynamics within them, on the other. The combination of these factors will determine the challenges and opportunities the industry faces, and the appropriate responses to address them. The solutions to the challenges of decarbonization, competitiveness, economic security, and the potential social consequences of the shift to zero emissions will be highly dependent on these factors.

The level of global tensions and international cooperation could result in four scenarios: protectionist rivalry, competitive coexistence, unilateral dominance, and strategic collaboration. These scenarios, detailed below, are not mutually exclusive and may overlap in various ways. They are not predictions but frameworks for imagining possible futures. The actual trajectory of the automotive industry will likely involve elements of each scenario, shaped by complex geopolitical and economic dynamics.



SCENARIO 1: PROTECTIONIST RIVALRY

– High global tensions & low international cooperation

This is a worst-case scenario (short of a generalized armed conflict), characterized by rising trade barriers, national industrial policies aimed at self-sufficiency, and limited cross-border investment.

Driven by concerns over unfair competition and national security, additional Western countries follow Washington's path, seeking to exclude Chinese EV producers and suppliers from their markets. The US escalates trade tensions, further eroding the multilateral trading system and triggering tit-for-tat responses that fuel greater protectionism worldwide. The new US administration imposes a series of tariffs and trade barriers targeting the automotive sector, disproportionately impacting the EU's premium car segment and restricting its access to the North American market.

European automakers increasingly shift production to North America, with greater localization of manufacturing across the NAFTA region and other key markets to mitigate the impact of tariffs. In parallel, the EU adopts a mix of defensive measures, including high tariffs on Chinese EVs, and offensive actions, such as restricting imports of vehicle connectivity systems and granting massive subsidies to boost domestic production.

China retaliates with measures such as trade barriers on Western goods and export restrictions on critical raw materials, further escalating trade tensions and deepening the fragmentation of the global trading system.

A crisis in the Taiwan Strait would create even greater geopolitical tensions, leading to severe disruptions in the global battery supply chain and grey-area measures like consumer boycotts of Western brands. Critical raw materials, many of which are refined in China, could become weaponized as trade restrictions and supply bottlenecks limit access to essential inputs for battery production across Europe.

The resulting shortages make it impossible for manufacturers to meet decarbonization targets, compelling a return to ICE and the exploration of alternative powertrain technologies to sustain automotive production. In this scenario, the EU is unable to meet the 2035 targets and shifts its focus towards hybrid drivetrains, increased investment in hydrogen, and continued reliance on ICE.

Western brands face consumer boycotts in China, fueled by heightened nationalist sentiment and political tensions, which lead to a significant drop in sales for European automakers in the Chinese market and compound the financial pressures from disrupted supply chains and lost revenues.

This results in a bifurcation of the automotive industry, with separate and incompatible standards, limited innovation, and higher costs and operational challenges due to diseconomies of scale. It prompts a re-evaluation of production and investment strategies, as the localization of production undermines economies of scale and complicates the EU's efforts to balance a cohesive decarbonization agenda with maintaining global market reach.

SCENARIO 2: STRATEGIC COLLABORATION

– Low global tensions & high international cooperation

This scenario envisions positive developments, where governments prioritize global trade norms and engage in structured dialogues to establish common standards. Collaborative efforts focus on addressing shared challenges, such as decarbonization and improving production efficiency.

Here, international cooperation is high, with joint efforts to build resilient and secure supply chains for critical materials and batteries. The EU establishes a cooperation initiative with partner countries for joint materials and battery production, with tariff-free trade in zero-emissions vehicles. The EU and the US build a partnership to reduce obstacles to transatlantic EV trade. The EU and China promote joint ventures between their companies within Europe, fostering investment, agreed-upon technology transfers, job creation, and the stable supply of critical minerals.

Critical raw materials agreements with alternative suppliers outside China play a pivotal role in diversifying Europe's CRM sources. By establishing long-term trade partnerships and developing effective CRM extraction and refining capacities within allied regions, the EU reduces its dependence on vulnerable supply chains. Additionally, recycling initiatives for battery materials help recover critical minerals domestically and contribute to a circular economy for key components.

There is greater standardization in the industry, facilitating interoperability and reducing investment risks. This fosters a more integrated global EV industry with increased innovation, lower costs, reduced threats to economic security, and faster decarbonization.

Several favorable developments converge to rapidly accelerate consumer acceptance of EVs in Europe. Following the introduction of the 2025 CO_2 standards, automakers launch a range of lower-cost EV models, supported by advancements in battery technology that improve efficiency and drive down production costs. These factors lead EVs to become less expensive than internal combustion engine vehicles by the late 2020s, which boosts their attractiveness to consumers. Meanwhile, an increase in US gas production results in stabilized energy markets and falling utility costs, which eases the operational costs of EVs and further encourages consumers to make the switch.

While this signals an optimistic shift towards sustainable mobility, it also poses substantial challenges for traditional suppliers specializing in internal combustion engine components, who face job losses as demand for these parts declines. However, the booming EV sector – with its demand for batteries, charging infrastructure, and specialized components – provides significant opportunities for job creation and economic growth, which may offset these losses.

SCENARIO 3: COMPETITIVE COEXISTENCE

– High global tensions & high international cooperation

Unlike purely positive or negative scenarios, this scenario paints a mixed picture where competition and cooperation coexist. While some countries may engage in protectionist measures, others prioritize collaborative efforts to advance the automotive industry.

Governments recognize the need to maintain a global industry while addressing concerns about fair competition and national security. Western countries implement trade defense measures such as tariffs on Chinese EVs, while simultaneously engaging in strategic partnerships and joint ventures with Chinese companies. This scenario represents a 'balancing act,' involving carefully crafted strategies and diverse actions.

The outcome is a high degree of regionalization, with countries forming trade blocs, prioritizing internal economic goals, and engaging selectively in global trade.

This leads to a multipolar automotive industry with varying levels of integration and competition across regions.

SCENARIO 4: UNILATERAL DOMINANCE

– Low global tensions & low international cooperation

In this scenario, a single region or country dominates the EV industry, leveraging technological leadership, market size, and control over critical resources. China, with its established dominance in battery production and EV manufacturing, capitalizes on its competitive advantages to secure a large share of the global market, mirroring its ambitions in other 'green' technologies

By 2030, the EU automotive industry faces accelerated decline as Chinese manufacturers rapidly expand their presence in the European market. Chinese automakers not only dominate the mass-market EV segment but also begin to attract younger premium customers, drawn to the advanced technology and innovative design of Chinese vehicles. A breakthrough in autonomous driving technology within China propels its EVs to achieve full autonomous driving capabilities – something EU producers have yet to accomplish. The technological edge positions Chinese EVs as the preferred choice for a new generation of consumers across all segments.

The competitive advantage of Chinese automakers – driven by imports of complete knock-down kits (CKD) and vertically integrated supply chains that minimize reliance on local EU suppliers – leads to a wave of closures among European suppliers and significant job losses across the region. Mass-market OEMs also face severe challenges, as Chinese EVs continue to gain ground in global markets. This structural crisis threatens the industrial base and economic stability of key European manufacturing regions.

Other regions also struggle to keep up, leading to a dependence on Chinese technology and supply chains. This results in a less diverse and potentially less innovative automotive industry, with limited competition to drive down costs or accelerate technological advancement. Other countries take a variety of different paths, such as continued production of internal combustion engine drivetrains, hybrids, and hydrogen vehicles.

– Factors influencing the scenarios

The scenarios outlined in this report are shaped not only by the interplay between global tensions and barriers on one side, and international cooperation on the other, but also by several additional factors critical to the EV industry's evolution:

First, government support measures, including incentives and infrastructure investments, alongside emissions standards, will play a crucial role in shaping the EV industry's trajectory. The different regulatory frameworks in China, Europe, and the United States highlight the potential for diverse approaches to EV adoption.

Second, technological advancements, such as innovations in battery technology, the expansion of charging infrastructure, and software-defined vehicles, will most certainly influence the competitiveness of the automotive industry. Breakthroughs like solid-state batteries and other advanced technologies have the potential to disrupt market trends in the medium- to long-term.

Third, securing access to critical materials and developing resilient supply chains for batteries will be vital for the sustainable growth of the EV industry. Regional variations in battery chemistries and production capacities further emphasize the importance of supply chain management.

Fourth, consumer adoption of EVs will hinge on factors like purchase price, range anxiety, charging convenience, and model availability. The growing market for used electric cars could play a role in increasing affordability and accessibility.

Finally, the direction of US trade policy under the new administration will greatly influence each of these scenarios.

The election of the 47th president of the United States has sparked a flurry of analyses of campaign promises and comparisons with the actions of the first Trump administration.[128] Ahead of the inauguration on 20 January 2025, analysts have focused on both campaign commitments and recent statements, including proposals to raise tariffs on Chinese imports to as high as 60% and impose import tariffs on goods from the rest of the world at rates between 10% and 20%. Additional tariffs on imports from Canada,

128 Fabry, E.& Leichthammer, A. (2024) 'The EU's Art of the Deal: Shaping a unified response to Trump's tariff threats.'.

Mexico, and BRICS countries are also under consideration, particularly if efforts to establish an alternative to the US dollar as the currency for international trade persist. Speculation further extends to potential measures involving the IRA, environmental regulations, and the implications of the president-elect's close relationship with Tesla's CEO, Elon Musk.

President Trump made it clear that he would use import tariffs as instruments to address bilateral trade deficits, support US industries, promote domestic job creation, and punish what he perceives as 'unfair' trade practices or regulations contrary to US interests.

The automotive industry is expected to be among the sectors most susceptible to policy changes, alongside information technology, high-tech products, and agriculture. President Trump has already revoked Biden's 50% EV target by 2030 and frozen unspent charging fund.

Further adjustment of IRA schemes can be expected as well as the imposition of tariffs, and the responses of major trading partners.

If the first Trump administration is any guide, we can expect unpredictability, volatility and disruption, tempered by a transactional approach that may mitigate the impact of new measures or address specific vulnerabilities.

Possible scenarios range from the implementation of broad US tariffs on imports from all sources to more targeted, bilateral tariffs aimed at specific trading partners or groups. The degree of disruption in international trade over the coming years will largely depend on the reactions of trading partners – whether they retaliate, and at what extent.[129]

129 Tariff scenarios for 2025: This briefing by Simon Evenett of the Global Trade Alert includes a useful table outlining the possible consequences of the four tariff scenarios, factoring in a strong US dollar. See also *Preparing for tariff increases* and *Why bilateral threats are the way forward*.

VIII. Conclusion

This report has explored the transition of the European Union's automotive industry towards electrification within the context of the global EV market, focusing on the challenges posed by decarbonization, competitiveness, and economic security objectives, as well as the industry's competitive standing relative to China and the United States.

The analysis reveals a complex landscape. While the EU is committed to sustainability and innovation, it faces significant challenges in keeping pace with the rapid advancements and investments made by its competitors.

China's dominance in the EV sector, achieved through early and substantial investments, strategic industrial policies supported by massive state support, and a holistic approach to building a complete EV ecosystem, underscores the difficulties confronting the European automotive industry. Chinese companies have become leaders in battery technology, production capacity, and cost-competitiveness, largely due to the government's focused strategic planning and resolve to move into EVs.

In contrast, the EU's transition has been slower and more fragmented. While environmental and CO_2 reduction regulations have been implemented, alongside initiatives to promote EV adoption and support a European battery value chain, the scale of investment and pace of innovation have lagged behind.

This disparity is particularly evident in battery manufacturing capacity. China is projected to control two-thirds of global battery production by 2030, with South Korea and Japan also holding significant shares.[130] Although Europe aims to increase its capacity, it faces a steep climb, starting from a lower base and contending with significant challenges in scaling up production quickly enough to meet surging demand.

The technological and cost-competitive advantages of Chinese EV manufacturers are challenging the competitiveness of the EU automotive industry, a cornerstone of the European economy.

Several factors contribute to the EU's innovation gap in producing cost-competitive EVs. First and foremost, the EU lacks a unified and aggressive industrial strategy comparable to China's or the funding mechanisms provided by the US Inflation Reduction Act. Second, Europe faces higher production costs than China, making it more difficult for European manufacturers to compete on price. Third, European car

130 IEA (2024) Batteries and Secure Energy Transitions, World Energy Outlook Special Report.

manufacturers have generally been slower to transition to EVs than their global counterparts, with a few notable exceptions. Lastly, the EU's bold, progressive, but often complex regulatory landscape, while focused on sustainability, often presents additional challenges for industry.

Europe can and must act decisively to future-proof its automotive industry. This report presents a set of policy options spanning regulatory measures, trade policy instruments, industrial strategies, and infrastructure investments. While we have deliberately not prioritized specific recommendations, it is clear that a holistic and coordinated approach is essential to bridge the innovation gap, ensure the long-term competitiveness of the European automotive industry, and address the social challenges of transitioning to EVs. Any broad strategy for the industry should carefully examine the timing and sequencing of policy interventions – whether short-, medium- or long-term – and consider immediate risks, implementation timelines, and potential for maximum impact.

As the EU launches a Strategic Dialogue on the Future of the European Automotive Industry, the stakeholder consultations conducted for this report – spanning over 70 interviews and numerous events with industry representatives, policymakers, civil society, and other experts – offer a blueprint for inclusive and informed deliberations. We hope that the insights and policy options identified in this report can support the strategic dialogue and contribute to shaping a competitive, resilient, and sustainable automotive industry that meets Europe's climate, economic, and security objectives.

Moving forward, the EU must couple internal reforms and investments with a proactive, export-oriented trade strategy. By leveraging its technological leadership, the EU can secure greater market access and drive the global transition towards sustainable mobility. This approach would reinforce the global competitiveness of Europe's automotive sector while delivering on its broader climate objectives.

The transition to zero-emission mobility is a critical opportunity for the EU to achieve its climate goals and maintain its industrial leadership. However, the window of opportunity is closing rapidly. The EU must act decisively to build a new automotive ecosystem that can rival those of its competitors. Failure to do so risks a decline in the EU's automotive industry, significant social and economic repercussions, and the loss of its technological edge in a sector poised to define the future of mobility.

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