PERSPEKTIVE

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EV Cluster Hungary?

Co-location and co-evolution of German OEMs and Asian EV investors and the transformation of Hungary's and Europe's automotive value chains

Executive summary

Hungary has emerged as one of Europe's most important EV- and battery-related production locations as a result of the co-location of German automotive OEMs and Asian battery producers. This transformation represents an adaptation to the structural changes reshaping the global automotive industry and reflects a deliberate state-driven strategy aimed at preserving and strengthening Hungary's role within European automotive value chains during the transition from internal combustion engines to electromobility. This paper argues that Hungary's EV transition can be understood as a case of adaptation under structural constraints. By combining existing German automotive capacities with large-scale Asian battery investments, Hungary has managed to strengthen its position within European production networks and become a strategic bridge between European producers, markets and Asian technological capabilities.

At the same time, the paper highlights a central paradox. While Hungary has successfully repositioned itself within emerging EV value chains, the transition has largely reproduced the core features of its earlier development model: strong foreign ownership, external technological dependence, limited domestic embeddedness and modest local value addition and capture. Rather than fundamentally transforming Hungary's position within global value chains, the EV transition has resulted mainly in a reconfiguration of dependencies, increasingly linking German-led automotive production with Asian-controlled battery technologies and supply chains, with limited Hungarian participation.

The analysis introduces the concept of »strategic overshooting«. This describes the exceptionally rapid and large-scale expansion of EV- and especially battery-related capacities in Hungary. The attraction of these investments appears, however, to have exceeded the country's infrastructural, environmental and institutional absorption capacities. Consequently, the current model combines important short- and medium-term benefits – including industrial and employment growth, export expansion and strengthened strategic relevance within

Europe – with growing structural vulnerabilities, such as overspecialisation, rising fiscal and environmental costs, resource pressures and geopolitical exposure.

The paper also demonstrates that integration into technologically advanced sectors does not automatically lead to upgrading at the national level. Domestic firms remain only weakly integrated into EV-related value chains, especially in the case of vertically integrated Asian investors, which rely heavily on imported inputs and home-country supplier networks. Consequently, technological upgrading at the sectoral level has not yet translated into broad-based upgrading of domestic capabilities.

At the European level, the Hungarian case reflects broader tensions with regard to strategic autonomy, industrial policy and geopolitical competition. Europe's EV transition currently depends heavily on Asian battery technologies and know-how, while growing US–China–EU competition is increasingly shaping investment patterns and industrial strategies. In this context, Hungary occupies an intermediary position within a Germany–Hungary–Asia triangle, in which Germany provides demand, traditional technology and value chain governance; Asia supplies key technologies and inputs; and Hungary offers production capacities and an enabling institutional environment.

The paper concludes that the key challenge is no longer integration itself, but the transformation of integration into more embedded, innovation-driven and sustainable development with more benefits to the Hungarian economy. This would require a shift from rapid expansion of capacity towards stronger domestic embeddedness, supplier upgrading, improved policy coordination and greater attention to environmental, fiscal and social sustainability.

1. Introduction and background[1]

The global automotive industry is undergoing a profound transformation, driven by the transition to electric mobility. This shift entails not only a change in propulsion technology – from internal combustion engines (ICE) to battery-electric vehicles (BEVs) – but also a broader reconfiguration of global value chains, technological leadership and industrial power. Battery production has emerged as the industry's strategic core, reshaping patterns of value creation and control, while new actors, particularly from China and South Korea, are challenging the long-standing dominance of established automotive producers.

For countries heavily specialised in automotive manufacturing, this transformation represents both an opportunity and a risk. Hungary represents a particularly revealing case. Over the past three decades, it has developed into a major automotive production location within Europe, based on a foreign direct investment (FDI)-led model dominated by Western – especially German – multinational firms. In turn, the country has been deeply specialised in internal combustion engine-related activities, which are directly affected by the transition to electric mobility.

This has brought into being a fundamental strategic dilemma. On one hand, the EV transition may threaten Hungary's existing industrial base, given its technological specialisation and strong dependence on foreign lead firms. On the other hand, in recent years the country has attracted a new wave of EV- and battery-related investments, particularly from Asian firms, and has positioned itself as a key location within emerging European EV value chains.

The central question therefore is not simply whether Hungary has integrated into the EV transition, but how this integration should be assessed. Does the emergence of the EV–battery–automotive cluster constitute a strategy of industrial adaptation capable of securing a position for Hungary as a major European production location? Moreover, to what extent has this strategy generated significant positive – and negative – side-effects that were only partially anticipated by policymakers and economic actors? To what extent will this strategy reproduce existing patterns of dependency, limiting the scope for domestic upgrading and long-term development?

This paper argues that Hungary's EV transition can be understood as an attempt at adaptation under structural constraints. The country has managed to reposition itself within a rapidly changing industry and to attract key actors of the new technology. However, the implementation of this strategy has also resulted in substantial overcapacities and a range of unintended side effects that negatively affect the Hungarian economy. We call this »strategic overshooting«. Furthermore, the underlying characteristics of its development model – external dependence, limited domestic embeddedness and modest value capture – remain largely unchanged.

Against this background, the paper analyses the emergence of a new EV–battery–automotive cluster in Hungary, driven by the co-location of German automotive OEMs and Asian battery producers, and supported strongly by a state-driven industrial policy. It examines how this configuration is reshaping Hungary's position within global value chains and its implications for domestic upgrading, sustainability and long-term development.

The paper highlights that integration into technologically advanced EV activities does not automatically lead to upgrading. It also argues that too proactive an industrial policy, disregarding local conditions, may lead to overshooting and exacerbate vulnerability. Ultimately, the key challenge lies in transforming this adaptive strategy into a more deeply embedded, innovation-driven growth path.

2. Overview of Hungary's automotive and EV–battery transformation: continuity, disruption and repositioning

2.1 Development of the traditional automotive industry based mainly on foreign companies

Hungary's automotive industry has undergone several waves of transformation over recent decades. After 1989, the industry was rebuilt on new foundations, driven by foreign direct investment (FDI). The initial phase of restructuring was driven by early FDI, which laid the foundations of a new, export-oriented production system. The companies involved included Opel (now Stellantis) in 1990, Suzuki in 1991, and Audi and Ford in 1993. During the 2000s and 2010s, this system consolidated primarily around German automotive manufacturers and dense supplier networks, including major firms such as Robert Bosch, Continental, ZF, Schaeffler, Knorr-Bremse and Thyssenkrupp, alongside the Japanese OEM Suzuki, as well as Japanese, French, US and other international suppliers. Mercedes-Benz Group began production in Kecskemét in 2012, while BMW announced its investment in Debrecen in 2018, with production starting in 2025. As a result of a recent capacity extension, Kecskemét became the largest European Mercedes car factory with production of 400,000 cars a year.[2] Together with Audi (200,000 cars a year) and BMW (150,000 cars a year) Hungary became a major location of German premium car producers. Domestic suppliers continue to play a secondary role, with only a few larger firms – such as Fémalk, Hajdú, Videoton, Rába and Csaba Metál – achieving deeper integration into global value chains. Over time, selective upgrading also occurred, especially in engineering and development.[3] However, these functions remain largely embedded in multinational corporate networks rather than in an innovation system rooted in the host economy.

As a result, the Hungarian automotive sector developed into a well-performing – in terms of output, exports and jobs – but structurally dependent model, characterised by strong export orientation, foreign ownership dominance and relatively limited domestic embeddedness. Upgrading has been selective and driven largely by multinational strategies.

2.2 The EV turn: entry of Asian investors, disruption and reconfiguration

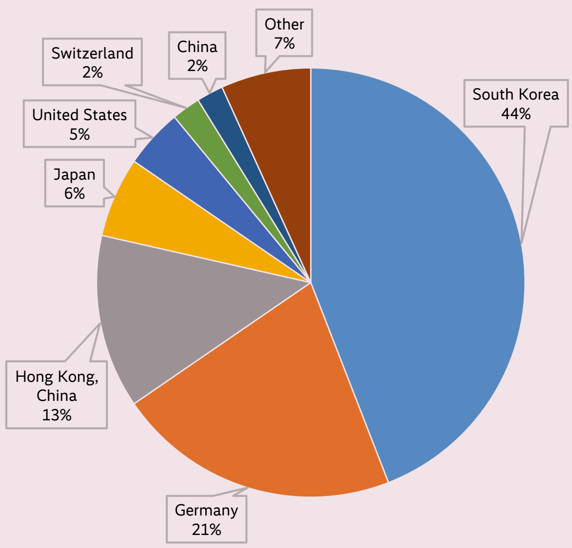
With the global shift to electromobility, a new phase began in the development of Hungary's automotive sector in the second half of the 2010s. The entry of Asian firms linked to the EV transition fundamentally reshaped the structure of Hungary's automotive ecosystem. From around 2016–2017, South Korean companies (Samsung SDI and SK On) were the first to invest (see Section 5), followed by Chinese investors. CATL, EVE Energy, Sunwoda and Huayou Cobalt have launched large-scale projects, strengthening Hungary's integration into China-linked battery value chains. The largest planned investment, CATL's factory in Debrecen, is expected to reach a capacity of 100 GWh in three phases (see Section 5). Overall, as of March 2026, 46 battery-related projects were either operational, under construction or announced. As a consequence, Hungary has rapidly become one of Europe's key locations for battery production.[4] Today, nearly all segments of the battery value chain are present in the country, from component production through cell manufacturing to recycling, while raw material extraction remains understandably absent. In parallel, Chinese EV producer BYD has also established a growing presence (see also Section 5).[5] These investments signalled a qualitative shift in Hungary's position within automotive value chains. While earlier integration, apart from Suzuki, was primarily embedded in European OEM-led production networks, the emergence of battery manufacturing introduced new actors, technologies and governance structures increasingly linked to Asian-led value chains. Furthermore, these developments reinforce Hungary's role as a key European location in emerging EV-related production networks.

2.3 The Hungarian automotive industry today: a major producer with a strong foreign presence and spatially dispersed distribution of capacities

At present, Hungary is one of the important automotive producers and exporters both in Europe and worldwide.[6] The leading players are foreign-owned firms with significant investments: in NACE 27, Korea dominates with an FDI stock of 6.8 billion EUR (Figure 1), while Hongkong, China is ranked third with rapidly growing FDI.[7] Germany has

Fig. 1

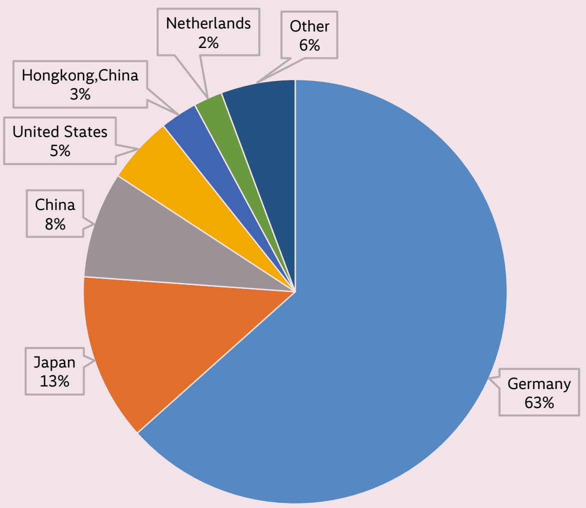
Composition of FDI stock in manufacture of electrical equipment (NACE 27) by investing countries, 2024 (%)



Source: Hungarian National Bank

Fig. 2

Composition of FDI stock in manufacture of road vehicles (NACE 29) by investing countries, 2024 (%)



Source: Hungarian National Bank

maintained a persistent lead in NACE 29 (Figure 2), with a total FDI stock of 11.4 billion EUR, while Hongkong and China appear as new source countries, their combined share approaching that of Japan (mainly Suzuki).

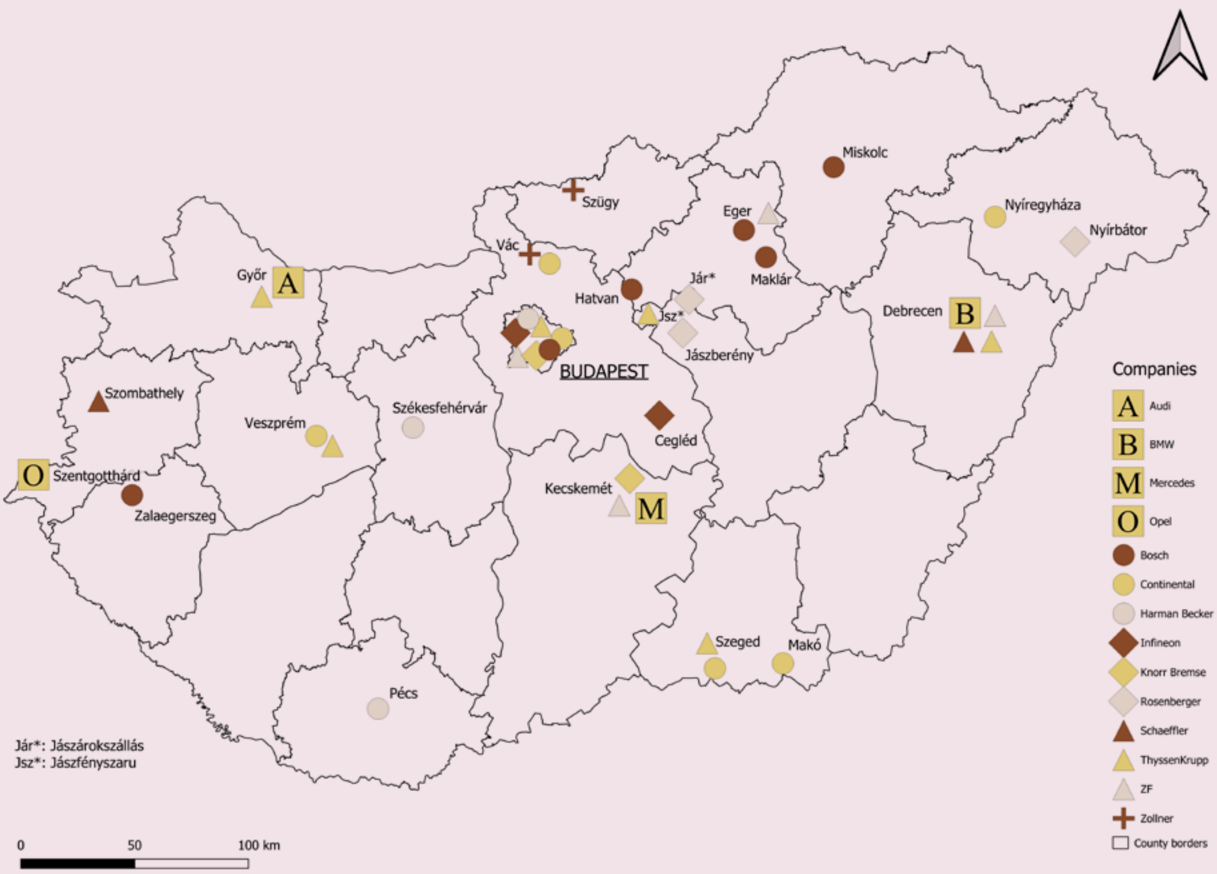
The new wave of FDI has also reshaped Hungary's economic geography. The co-location of German automotive OEMs and Asian battery producers has created new industrial hubs, especially in eastern Hungary (see Figures 3 and 4), reinforcing both the spatial concentration and the expansion of the automotive industry.[8]

2.4 The European and East-Central European context: competition and concentration

There has been a pronounced dual structural transformation within EU automotive manufacturing, characterised by both strong output growth and a marked geographical reallocation of production. Production of automotive and other transport equipment tripled between 1995 and 2024 and shifted towards Central and Eastern Europe, driven by efficiency-seeking FDI and fragmentation of value chains (Figures 5 and 6), Labour-intensive and

Fig. 3

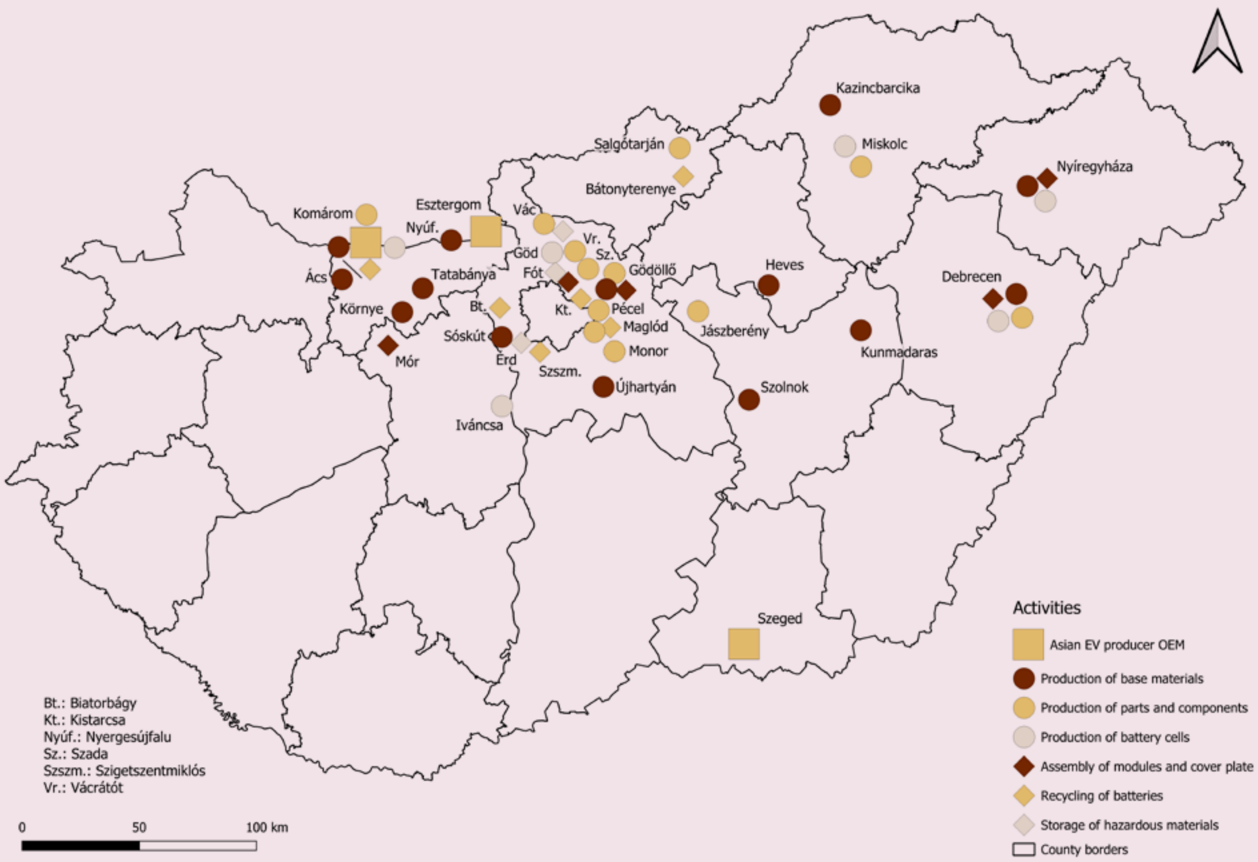
Location of German OEMs and the largest (1,500+ employees) suppliers in Hungary



Source: Based on data provided by Opten, ceginformacio.hu and company reports

Fig. 4

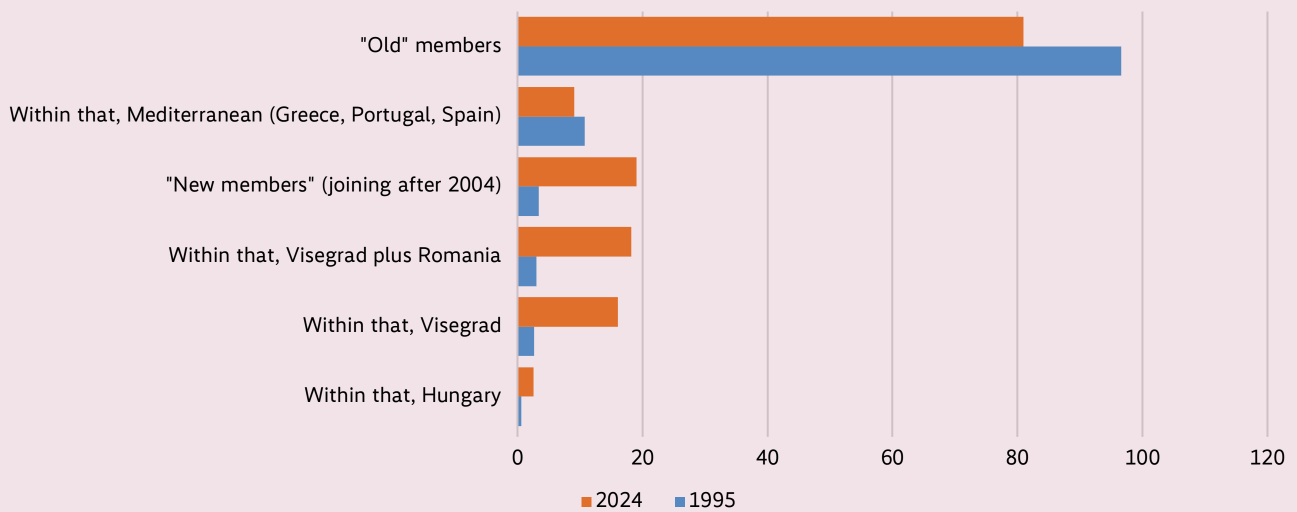
Locations of Asian participants in EV value chains in Hungary



Source: Based on data provided by Opten, ceginformacio.hu and company reports. The figure shows the situation as of April 2026

Fig. 5

Breakdown of output of manufacture of motor vehicles, trailers, semi-trailers and of other transport equipment industries (NACE 29-30) among present European Union member countries, 1995 and 2024 (%)

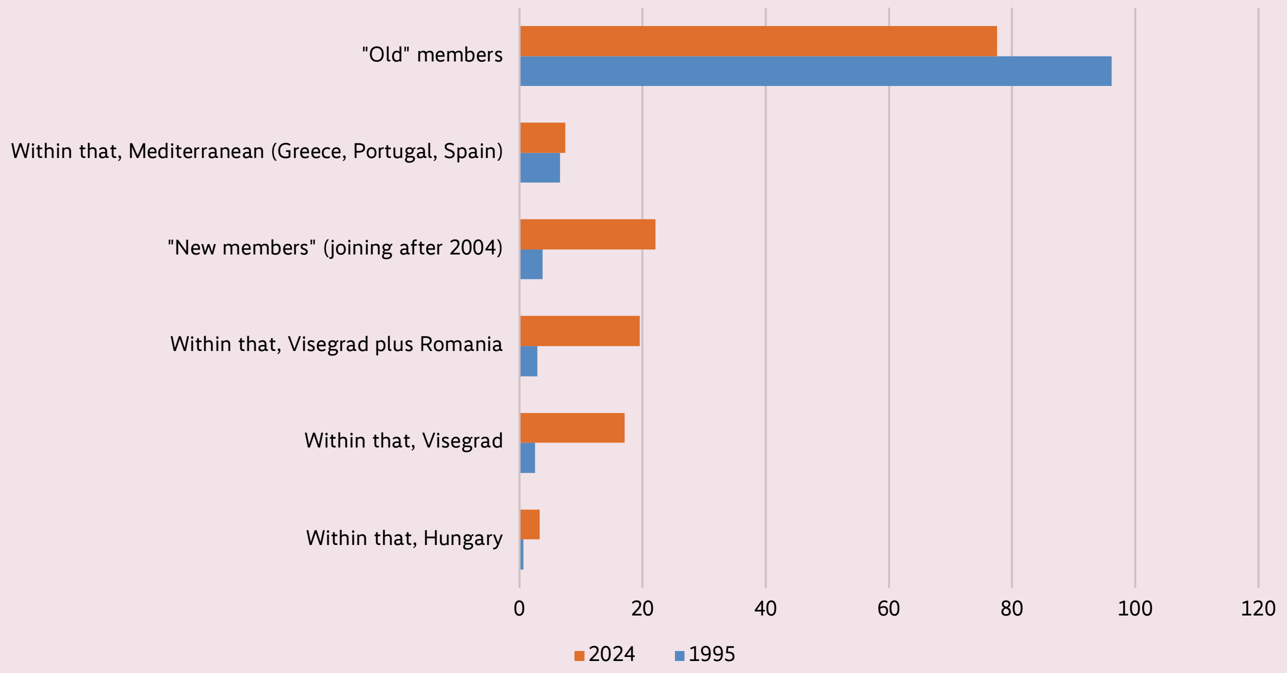


Note: Without the United Kingdom, »old« members include: Belgium, Denmark, Germany, Ireland, Greece, Spain, France, Italy, Luxembourg, Netherlands, Austria, Portugal, Finland, and Sweden; Mediterranean: Greece, Portugal, Spain; »new« members: Bulgaria, Czechia, Estonia, Croatia, Cyprus, Latvia, Lithuania, Hungary, Poland, Romania, Slovenia, Slovakia; Visegrad: Czechia, Hungary, Poland, Slovakia; 2023 data, where 2024 is not available.

Source: Eurostat national accounts

Fig. 6

Breakdown of output of manufacture of electrical equipment (NACE 27) among present EU Member States, 1995 and 2024 (%)



Note: Without the United Kingdom, »old« members include: Belgium, Denmark, Germany, Ireland, Greece, Spain, France, Italy, Luxembourg, Netherlands, Austria, Portugal, Finland, and Sweden; Mediterranean: Greece, Portugal, Spain; »new« members: Bulgaria, Czechia, Estonia, Croatia, Cyprus, Latvia, Lithuania, Hungary, Poland, Romania, Slovenia, Slovakia; Visegrad: Czechia, Hungary, Poland, Slovakia; 2023 data, where 2024 is not available.

Source: Eurostat national accounts

assembly activities have increasingly moved towards Central and Eastern Europe, while core functions often remained in the »old« Member States. A similar but even more pronounced dynamic can be observed in electrical equipment manufacturing (NACE 27, including batteries), where output more than doubled over the period. Here, the rise of CEE countries appears to have been even stronger.

The automotive sector has become a dominant industrial pillar among the Visegrad countries, particularly in Slovakia and Czechia, with Hungary also showing strong specialisation. The country differences can be attributed to path dependence, economic policy factors and size of economy.[9] Poland is considerably less specialized and more diversified, with lower foreign value-added dependence and a smaller productivity gap between domestic and foreign-owned firms. In the e-battery industry, the South Korean LG Energy Solution is the biggest player, with some smaller-sized foreign and domestic investments, resulting, by European comparison, in medium capacities and strong export performance. Czechia, building on strong industrial traditions, the survival of the Škoda brand (albeit in German hands), a more advanced local supplier base and a more stable industrial policy, exhibits higher domestic embeddedness and value added than its regional peers.[10] In e-batteries, however, Czechia is at present a negligible production location.[11] Slovakia shows the highest level of automotive specialisation, low diversification, weak local embeddedness and the highest foreign value added, reflecting its role as a foreign-led assembly platform with limited upgrading. In order to preserve its automotive positions within EV-related challenges, the government attracted one battery investment in joint venture form (the Chinese Gotion with the local InoBat) and a fifth car manufacturer (Volvo, owned by the Chinese Geely Holding Group).[12] Hungary is also highly specialised and foreign-dominated, but benefits from a stronger presence of premium brands, somewhat lower specialisation compared with Slovakia and Czechia, and a more active short- to medium-term government strategy aimed at preserving the sector. The upshot of the latter, as already mentioned, is the highest European capacity in e-battery production, with Korean and Chinese firms (Tables 1 and 2).

Compared with its regional peers, Hungary's EV transformation thus displays some distinctive features, most notably the exceptionally strong specialisation in EV batteries and exclusive reliance on Asian battery producers. This reflects a deliberate strategy of the previous government aimed at stabilising the position of the industry by attracting large-scale Asian investments to complement existing German OEM capacities.

Table 1

Snapshot of manufacturing of motor vehicles, trailers and semi-trailers industry (NACE 29) in the V4 countries (2023)

	Hungary	Slovakia	Czechia	Poland
Share in manufacturing value added (%)	15.8	22.0	20.3	7.0
Share in manufacturing output (%)	24.4	38.3	29.4	10.7
Value added/output ratio (%)	15.3	11.8	18.3	17.4
Share in manufacturing employment (%)	12.4	14.9	14.5	10.2
Share in manufacturing exports (%)	28.0	44.3	40.0	20.1
Share in manufacturing FDI inward stock (%)	21.5	28.7[2]	19.4	15.0
Share of foreign value added[1] (%)	90.4	93.8	87.3	81.7
Productivity gap[2] (apparent labour productivity of foreign firms as a percentage of domestic firms)	189.2	176.7	170.6	142.2
Number of enterprises	493	1 358	1 164	1 738
Number of passenger cars produced	507 225	1 080 000	1 397 816	299 300

[1] Together with manufacture of other transport equipment industry.
[2] Data from 2022.

Sources: Eurostat, OICA (2025) and OECD (2025)

Table 2

Snapshot of the manufacture of electrical equipment industry (NACE 27) in the V4 countries (2023)

	Hungary	Slovakia	Czechia	Poland
Share in manufacturing value added (%)	8.7	5.4	8.9	5.5
Share in manufacturing output (%)	10.6	6.1	7.3	6.2
Value added/output ratio (%)	19.2	18.3	32.1	23.6
Share in manufacturing employment (%)	7.5	7.3	8.3	4.2
Share in manufacturing exports (%)	11.4	6.3	8.9	11.5
Share of foreign value added (%)	91.6	78.0	73.6	73.0
Productivity gap (apparent labour productivity of foreign firms as a percentage of domestic firms)	207.0	113.6	134.8	136.1
Number of enterprises	857	2 298	8 929	2 742
Increase in production volume (2015–2023, %)	252	–	39	109

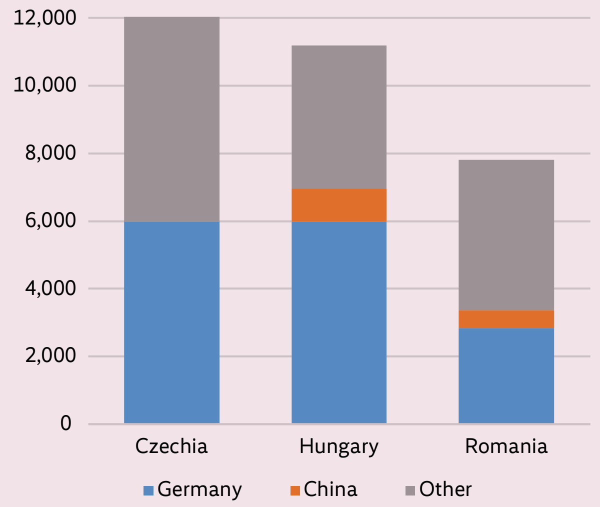
Sources: Eurostat Note: FDI data are missing

2.5 Automotive and EV industry: a key sector in Hungary

The automotive industry is the leading manufacturing sector in Hungary. It employs more than 100,000 workers, representing approximately 3 per cent of total employment. It is highly export-oriented, with a concentrated export market: Germany absorbs almost one third of vehicle exports and the rest of Europe the other two thirds.[13] The industry is dominated by foreign-owned firms: in 2023, foreign-owned firms represented more than 95 per cent of output, over 90 per cent of value added, 83 per cent of employment, and 97 per cent of R&D expenditure in the sector. German-owned firms play a leading role, despite their small number (65), reflecting a highly concentrated industrial structure and the importance of economies of scale.[14] Domestic firms play a secondary role with a high productivity gap in relation to foreign-owned firms and limited contact with them, indicating the presence of a dual economy (Tables 1 and 2).

Fig. 7

Breakdown of FDI stock in the automotive industry (NACE 29–30) by ultimate owner's country (million EUR)



Note: For CEE countries, where data are available.

Source: Based on Eurostat balance of payments data

The sector's footprint extends far beyond vehicle manufacturing, encompassing, for example, chemicals, electronics, machinery, plastics, glass and logistics. This is even more true in the EV era, in which batteries and related R&D are often statistically classified outside the automotive sector, as a result of which its true scale is underestimated in the official data. Estimations put employment in the sector, including supplier industries, at 150–180,000, around 5 per cent of total employment and above 15 per cent of manufacturing employment in 2023.[15]

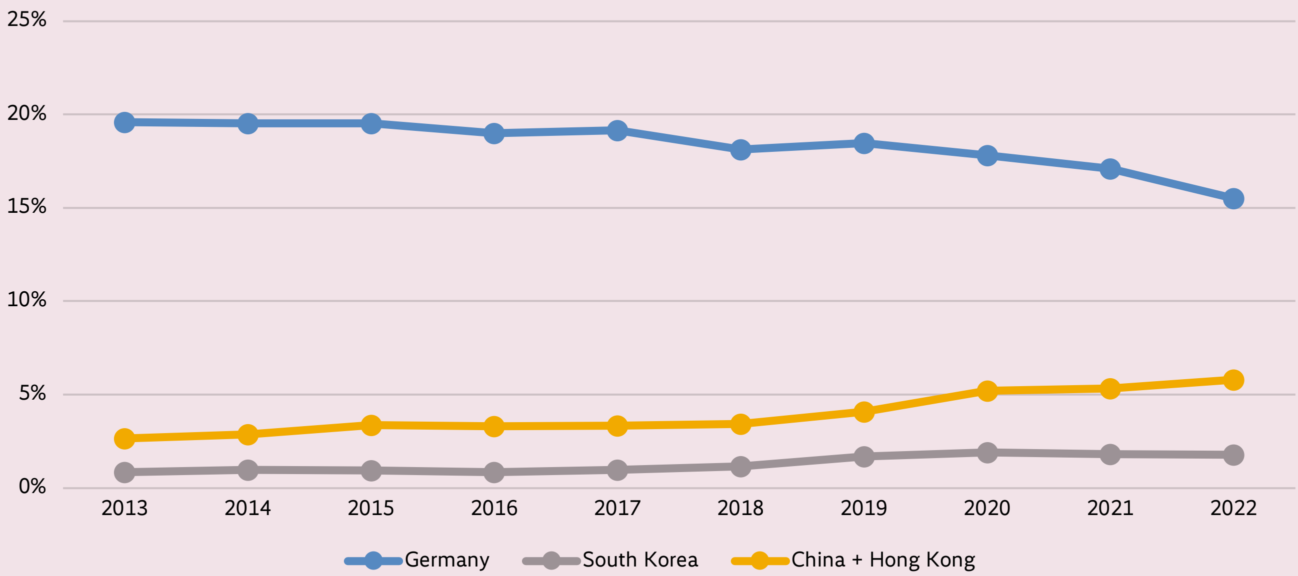
Despite the technological, and substantial structural and spatial shifts, Hungary's position in global value chains shows strong continuity. The country remains deeply integrated into international production networks, with high export intensity and a strong reliance on imported inputs. Our calculations based on TiVA data[16] indicate a persistent pattern: a high share of foreign value added in exports (among the highest in OECD comparison), relatively low domestic value-added content, and a significant productivity gap between foreign-owned and domestic firms. These features are characteristic of a downstream, assembly-oriented position within value chains.

The EV transition has altered the composition of these linkages, particularly by increasing the role of Asian inputs, but it has not fundamentally changed their nature. Hungary's supply chains are increasingly linked to Asian firms, even in regional comparison (Figure 7 and 8), while it continues to depend on European markets for demand. This has resulted in a reconfiguration rather than a transformation of Hungary's position: new actors and technologies are integrated into an existing structural framework.

The rise of the electrical equipment sector does not fundamentally alter this model. Despite rapid growth, the sector shows even higher and increasing dependence on

Fig. 8

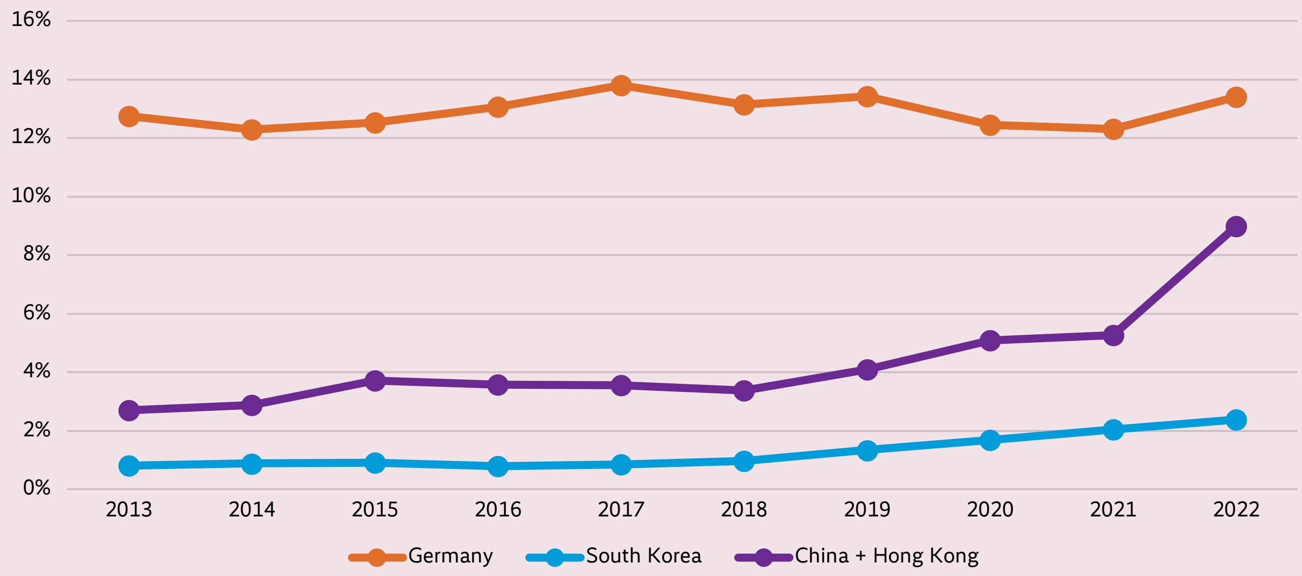
Origins of value added in gross exports (manufacture of motor vehicles, trailers, semi-trailers and other transport equipment)



Source: Authors' calculations based on OECD TiVA

Fig. 9

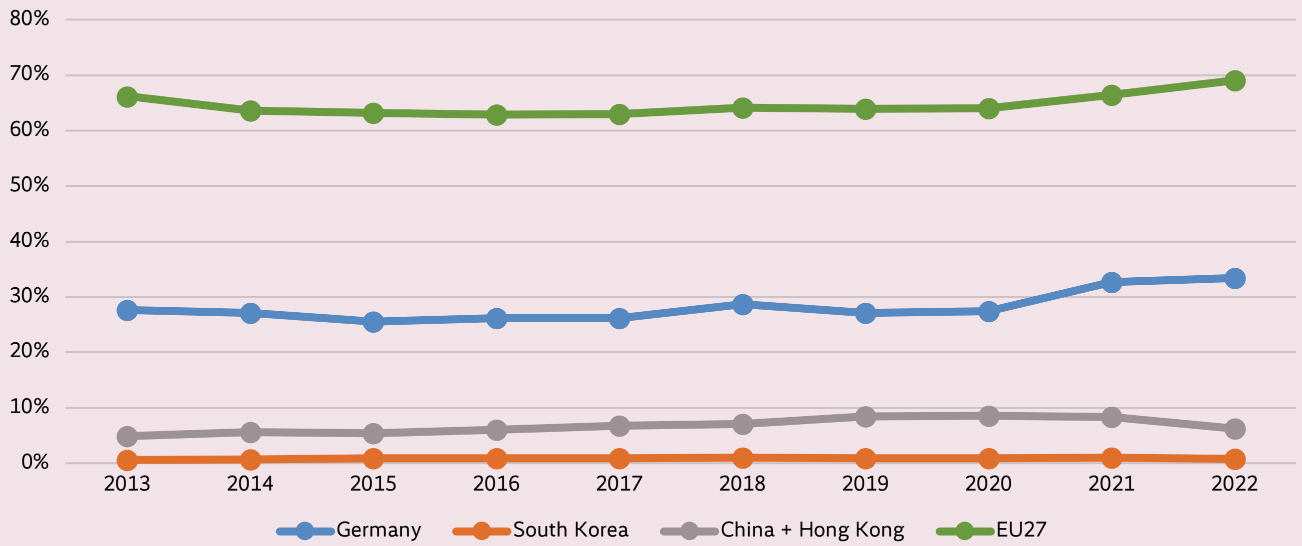
Origins of value added in gross exports (electrical equipment)



Source: Authors' calculations based on OECD TiVA

Fig. 10

Export destinations (electrical equipment)



Note: EU27 (including Germany)

Source: OECD TiVA

South Korean and Chinese foreign value added (Figure 9) and productivity gaps, while production is destined mainly for EU markets[17] (Figure 10). This indicates the export-platform nature of the Asian investments.

3. Unpacking investment dynamics: German OEMs and Asian EV/battery producers

Hungary's EV–battery–automotive cluster has emerged from the interaction of three key factors: German OEM strategies, Asian investor strategies, and a state-driven industrial policy framework. Their co-location has enabled Hungary's rapid repositioning within European automotive value chains and the country has become a key site where these actors co-locate. This has led to the emergence of a new EV–battery–automotive ecosystem that connects European production and demand with Asian technological capabilities. The following section unpacks these developments, focusing on the broader European context, the Hungarian policy environment, and firm strategies and interaction patterns.

3.1 EU policy and global context

This transformation is taking place in a broader European and global policy context. The EU increasingly links industrial competitiveness to the success of the green and digital »twin transition«.[18] Furthermore, the debate on the future of internal combustion engines shows that the green transition is not a linear process, but one shaped by technological uncertainty, competitiveness concerns and political compromises.[19]

The shift to electric mobility is not only technological, but also geopolitical, as control over battery technologies and critical raw materials has become increasingly concentrated in Asia, particularly in China. The EU faces growing dependence on external suppliers of key clean technologies and strategic inputs, while demand for battery minerals and rare earths is rapidly increasing. As China dominates several critical segments of battery value chains,[20] the EU faces a difficult balancing act between accelerating decarbonisation through affordable green technologies and reducing strategic dependencies by strengthening supply-chain resilience.[21]

EU policy responses have included strategic partnerships with resource-rich countries such as Chile, Namibia and Norway,[22] as well as efforts to accelerate the issue of permits and support domestic clean-technology projects. The designation of strategic projects and the streamlining of administrative procedures are intended to support the development of European industrial capacities.[23] In practice, these measures also create tensions as expanding extraction and battery production may trigger social and environmental resistance, while reducing external dependence may raise costs and slow the green transition.

The automotive sector is at the centre of these tensions. European carmakers remain globally competitive in vehicle design, engineering and final assembly, but they are less dominant in battery technologies than Asian firms.[24] Thus, the EV transition changes not only the technological basis of the automotive industry, but also its power relations. In this context, Central and Eastern Europe and within that Hungary becomes an important location for new EV-related production capacities. Consequently, this raises broader strategic questions for Europe. These include whether the type of forced embeddedness and technology transfer policies previously applied in China can be replicated within the European context; whether a genuinely European battery industry can be developed in the shadow of dominant Asian firms; and ultimately, whether such an autonomous European battery industry is feasible or even necessary.

3.2 Hungary's industrial policy model

The Orbán government's industrial policy played a central role in shaping the emerging EV cluster. The starting point – strong specialisation in and reliance on a, by regional comparison, weakly embedded foreign-dominated industry – has largely determined the policy response. Building on its long-standing FDI-led development model, the Hungarian government has actively repositioned the country as a key location for EV and battery investments, with a particular focus on attracting Asian firms, having recognised early on that the EU's green transition would reshape investment patterns.[25]

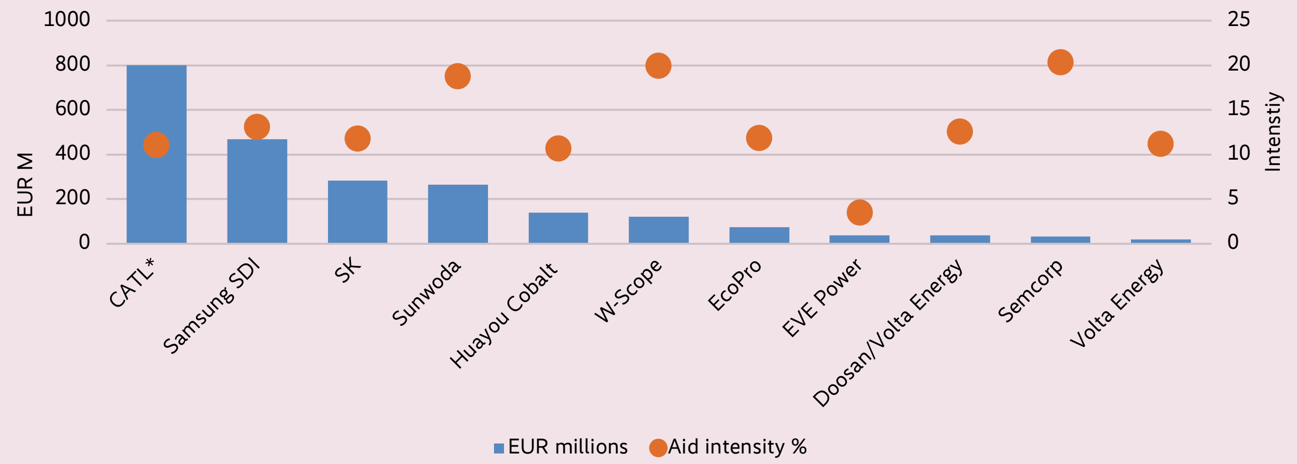
This strategy represents a form of proactive adaptation. After recognising the implications of the EV transition, the government aligned Hungary with the investment strategies of both German OEMs and Asian battery producers. This led to a rapid influx of large-scale investments and a strengthening of Hungary's position within European automotive GVCs. The explicit aim was to position the country as a major global and European battery production hub.[26] The strategy shifted from the attraction of FDI in general towards a more targeted industrial policy focused on battery production and electromobility.

However, this model relied heavily on state subsidies, infrastructure support and regulatory facilitation, while prioritising speed and scale over coordination and long-term integration.[27] Rooted in the overly centralised governance structure of the late Orbán regime, the approach was not in line with environmental, resource and innovation policies.[28] The 2021 National Battery Strategy,[29] for example, was not integrated into a broader development framework and was not made public for a long time.[30] These shortcomings are particularly significant given the resource intensity of battery production. Attracting investments by offering investors direct financial support[31] (Figure 11) has also been accompanied by extensive light-touch regulation.[32] Battery projects were frequently designated »priority investments«, enabling accelerated permitting and centralised decision-making. Furthermore, changes in public consultation and regulatory oversight reduced local influence and weakened enforcement in some cases.[33]

Hungary's industrial policy can thus be seen as strategically facilitating integration into a new sector, while reinforcing a development path characterised by external dependence and limited domestic embeddedness, while disregarding local specificities.

Fig. 11

Main cases of direct state aid to Asian battery plants between 2018 and 2025



Note: For CATL aid promised, but not yet fully contracted.

Source: Authors' compilation based on official press information

3.3 German OEM strategies

German automotive manufacturers remain the central actors shaping Hungary's automotive sector, but their strategic position is increasingly beset by the transition to battery-electric vehicles. Their long-standing strategy based on high-quality engineering, premium branding and globally fragmented production anchored in Germany is being challenged by intensifying competition and technological change.[34] Faced with the disruptive impact of electrification, they have adopted an adaptation strategy aimed at preserving their competitive position within Europe.

The shift to EVs creates several pressures. First, the sustainability of the premium-based profit model is uncertain, as price competition is increasing and new (mainly Chinese) competitors are able to offer technologically advanced vehicles at lower cost. Second, high production costs in Germany complicate the development of a competitive domestic EV manufacturing base, which increases the importance of lower-cost EU locations, including Hungary. Third, dependence on external markets, particularly China, introduces new strategic vulnerabilities and may require adjustments in production and innovation structures.[35]

In response, German OEMs aim to retain production within the EU to secure market access, while relying on external partners – mainly Asian firms – for battery technologies,[36] including through long-term partnerships.[37] At the same time, they are reorganising production systems to accommodate EV-specific requirements.[38] From the perspective of German OEMs, the Hungarian EV cluster represents an optimal configuration: it allows firms to combine cost-efficient production within the EU with access to Asian battery technologies, while preserving control over high-value functions such as R&D, design and strategic decision-making and providing a highly business-friendly environment. In this sense, the current model is closely in line with the adaptation strategy of German automotive firms.

From Hungary's perspective, the continued commitment of German OEMs represents a key element of the adaptation strategy. It ensures the maintenance of demand, integration into European production networks, and the retention of a central role in automotive manufacturing, as well as access to state-of-the-art technologies. On top of that, the organisational logic of German firms has changed little. Core technological capabilities and strategic decision-making remain concentrated at headquarters level, while local activities continue to focus primarily on production. As a result, the adaptation of German OEMs contributes to continuity in Hungary's functional position within value chains, limiting the scope for deeper upgrading.

3.4 Asian investor strategies

Asian investors, particularly from South Korea and China, have entered Hungary in the context of the global EV transition with a strategy that differs significantly from earlier waves of FDI. Chinese EV firms treat Europe as a major destination for »going global«.[39] Their primary objective is to secure direct access to the European market by establishing local production capacities, effectively establishing »bridgeheads« within the EU.[40] Producing within the EU allows them to avoid trade barriers, reduce transport costs and comply more easily with local regulatory requirements.

Advancing the »flying geese« government recommendation, these firms typically pursue large-scale, vertically integrated investment strategies[41] with strong support from the government.[42] Entire segments of the battery value chain, ranging from component production to cell manufacturing and, increasingly, recycling, are relocated or newly established in host countries.[43] This process is reinforced by »follow sourcing«[44] dynamics, whereby suppliers co-locate[45] with lead firms for logistical and operational purposes. Asian firms combine market access with strong cost efficiency and rapid scaling capabilities, indicating the export-platform nature of their projects. Spatial proximity to European automotive customers enables shorter lead times and closer integration into production processes. However, this localisation is often accompanied by limited local embeddedness. Firms are mostly vertically integrated and rely heavily on suppliers from their home countries, while decision-making remains centralised and domestic firms are typically involved only in marginal activities. This results in what can be described as a »transplanted ecosystem« model: production is relocated geographically, but ownership, control and technological capabilities remain largely external.

From a systemic perspective, the presence of these firms was a central component of the Orbán government's adaptation strategy. Without Asian battery producers, the country would not have been able to integrate into the core technological segment of the EV transition. Thus, the same features that enable rapid expansion also limit local benefits and may increase local costs. Production systems are often highly self-contained, relying on imported inputs, established supplier networks and centralised decision-making. Domestic firms are typically involved only in peripheral or service-related activities. The large-scale of investments may have negative local social, environmental or other consequences.

3.5 Co-location and interaction

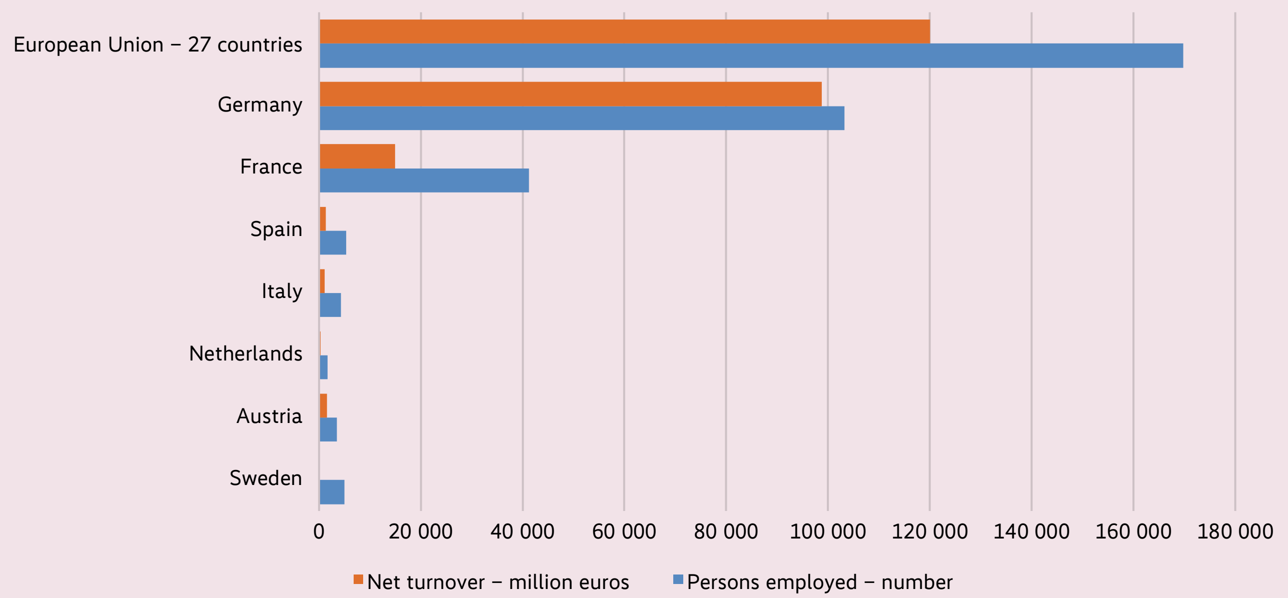
The co-location of German OEMs and Asian battery producers is a defining feature of Hungary's current industrial transformation. Their interaction is based on mutual dependence: European manufacturers require reliable battery supply,[46] while Asian firms seek stable demand and access to the EU market. This complementarity has created strong incentives for spatial concentration and co-location, particularly in emerging industrial locations such as Debrecen (see Section 5). In this sense, co-location represents a key mechanism of the adaptation strategy, enabling Hungary to position itself at the intersection of major global production networks.

This relationship is also asymmetric. Asian firms dominate key battery technologies and supply chains, while German OEMs retain control over final vehicle production and access to European markets. This division of roles is reproduced at the local level, resulting in a system of co-existing but only partially integrated production networks.

Empirical examples help to illustrate this pattern. BMW's decision to locate in Debrecen was followed by cooperation with the Chinese battery producer EVE Power, which established production facilities in close proximity.[47] Similar partnerships can be observed in the case of Volkswagen and Sunwoda,[48] and Mercedes[49] or BMW and CATL.[50] These collaborations often build on pre-existing relationships developed in China, where European, and especially German, OEMs have long-standing production and sourcing links (Figure 12).

Fig. 12

Net turnover and number of employees of selected European firms in China in the manufacture of motor vehicles, trailers, semi-trailers and other transport equipment (NACE 29), 2023 (million EUR and number)



Source: Eurostat FATS

In practice, interaction between the two groups of firms does not necessarily lead to integrated local ecosystems. German-led automotive networks and Asian-controlled battery systems often coexist with limited overlap, particularly in terms of supplier linkages and knowledge transfer (see Section 5 on Debrecen). The result is a spatially concentrated but organisationally fragmented industrial structure.[51] Furthermore, geopolitical tensions – particularly between the EU, the US and China – introduce additional risks to the stability of the model.[52]

4. Implications and impacts of Hungary's emerging EV cluster

The emergence of the EV–battery–automotive cluster in Hungary represents a profound industrial transformation with far-reaching economic, social, environmental and technological implications. This transformation is inherently ambivalent. Hungary has managed to reposition itself within a rapidly evolving sector at relatively high cost and without fundamentally altering its dependent role within global value chains. The present model does exhibit certain strengths, such as an effective strategy of rapid industrial repositioning, combining market access, cost advantages and policy support to attract globally leading firms with state-of-the-art technology in a key emerging sector. On the other hand, structural weaknesses include the cost, value capture problems (high and persistent foreign value added, limited upgrading and upgrading not translated into higher local gains), governance asymmetries with Chinese firms, the dual dependency structure and resource and legitimacy constraints.

4.1 Economic impacts

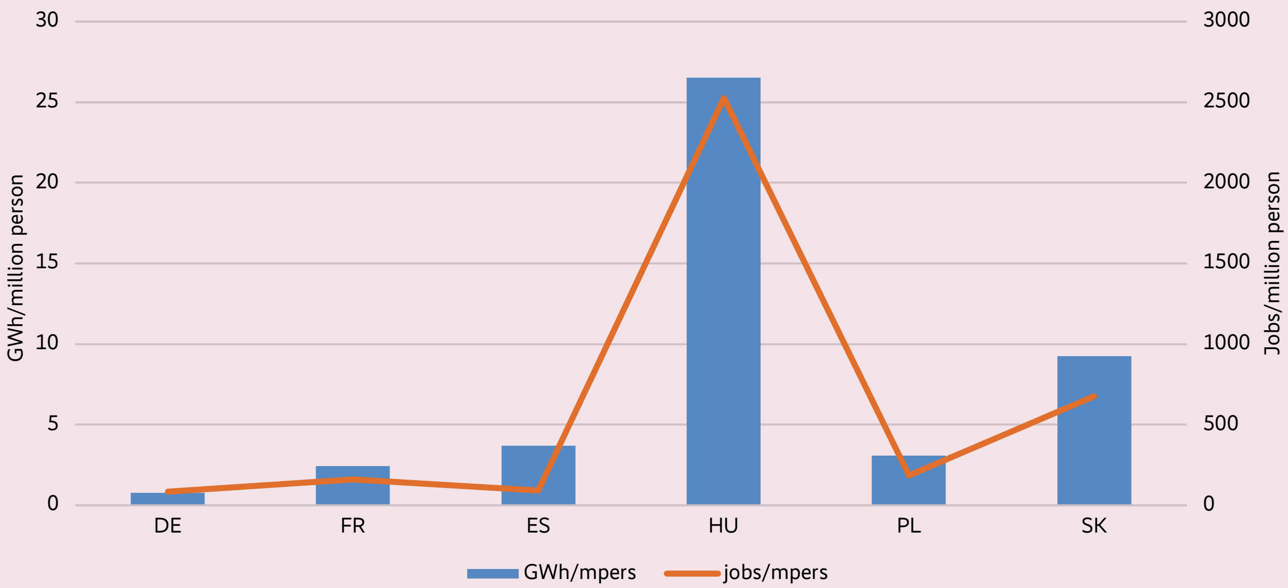
From a macroeconomic perspective, the expansion of EV-related investments has strengthened Hungary's position as a major European automotive location. Large-scale inflows of foreign direct investment, the rapid expansion of production capacities and the co-location of OEMs and battery producers have reinforced agglomeration economies and consolidated Hungary's role as an export-oriented manufacturing base.

Nevertheless, the limits of this growth model are increasingly visible. Overcapacities have developed, resulting in overspecialisation (Figures 13 and 14). This has led to substantially increased vulnerabilities and dependencies resulting from the sector's high export intensity.

Indeed, output dynamics have become more volatile, reflecting strong exposure to external demand fluctuations (such as the slowdown in global EV demand in 2024–2025) and technological uncertainty (Figure 15). Employment effects are also visible across a broader set of manufacturing subsectors linked to automotive production (Figure 16). However, recent trends suggest a slowdown in employment growth, reflecting labour shortages and broader macroeconomic constraints. Another factor may be that the emerging EV and battery industry is also characterised by exceptionally high levels of automation and robotisation. According to International Federation of Robotics (IFR) data, Hungary's industrial robot density has increased significantly over the past decade, driven mainly by foreign-owned automotive and electronics firms.[53]

Fig. 13

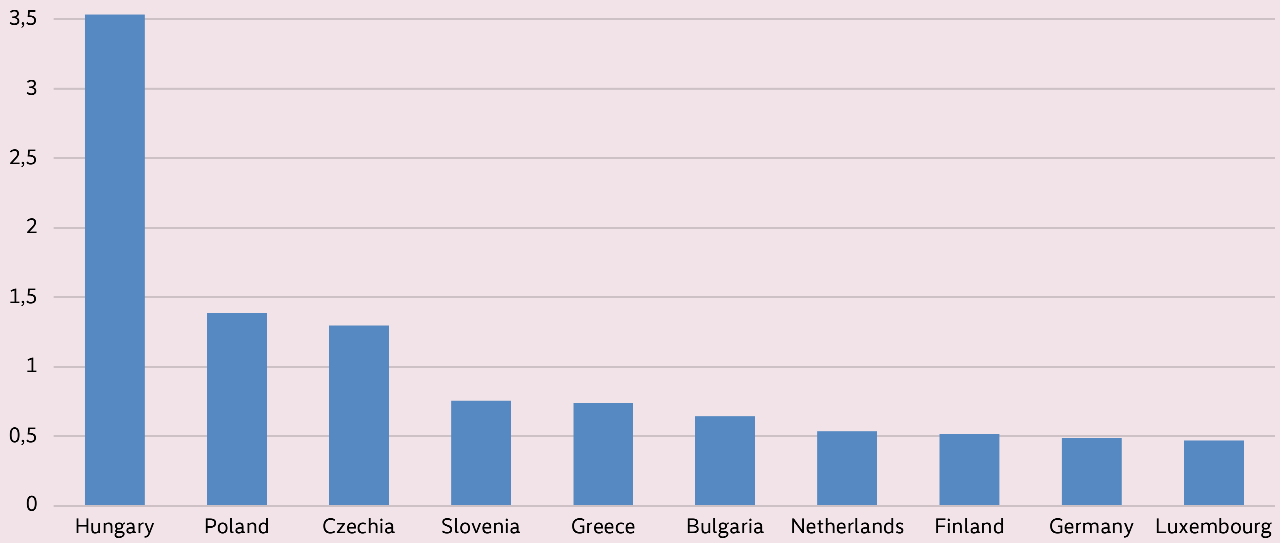
Battery capacities and planned jobs per million persons, selected European countries



Source: https://battery-news.de/en/battery-atlas-europe/, bruegel.org, population data are of 2025.

Fig. 14

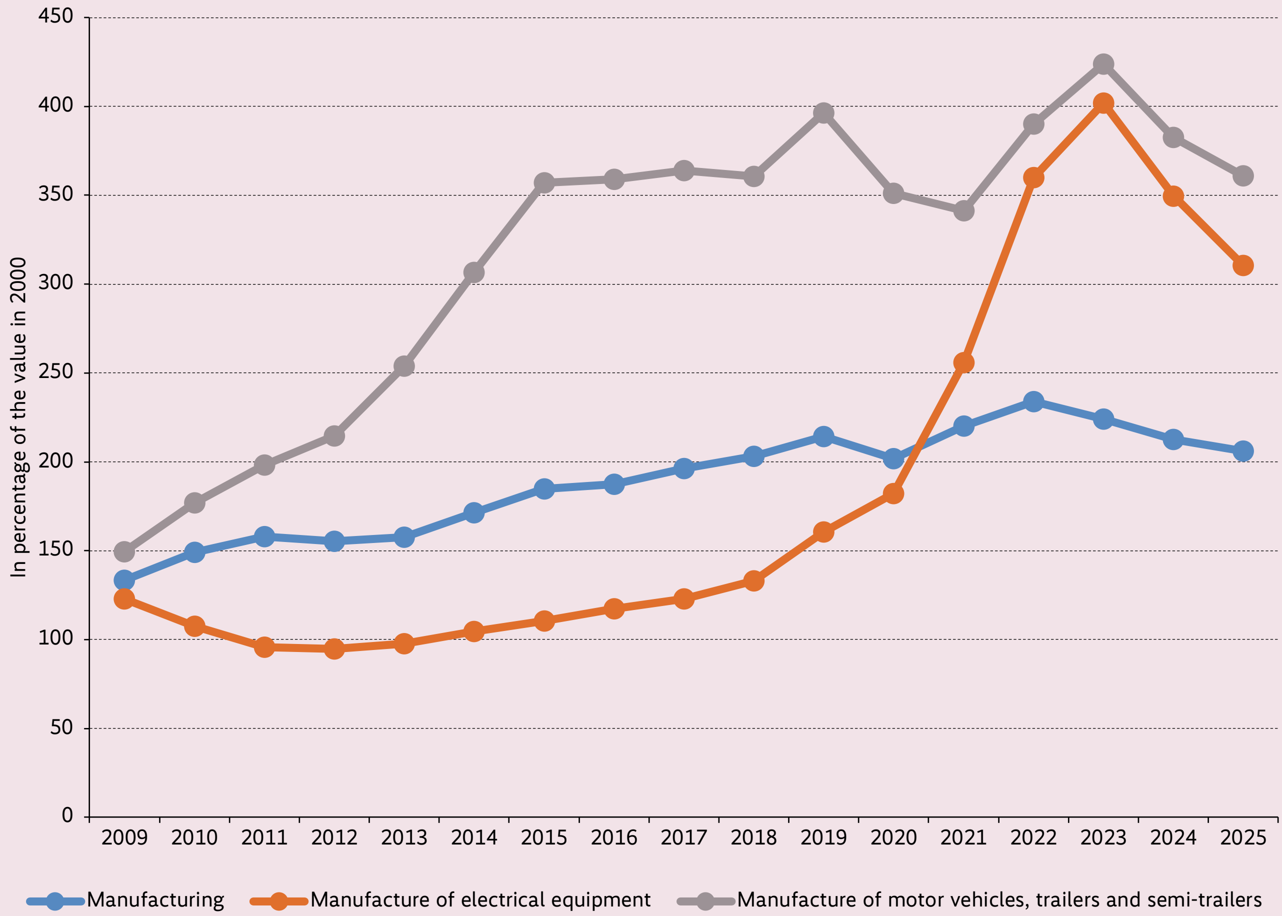
EU member countries with the highest share of e-batteries in total exports, 2025 (%)



Source: Eurostat

Fig. 15

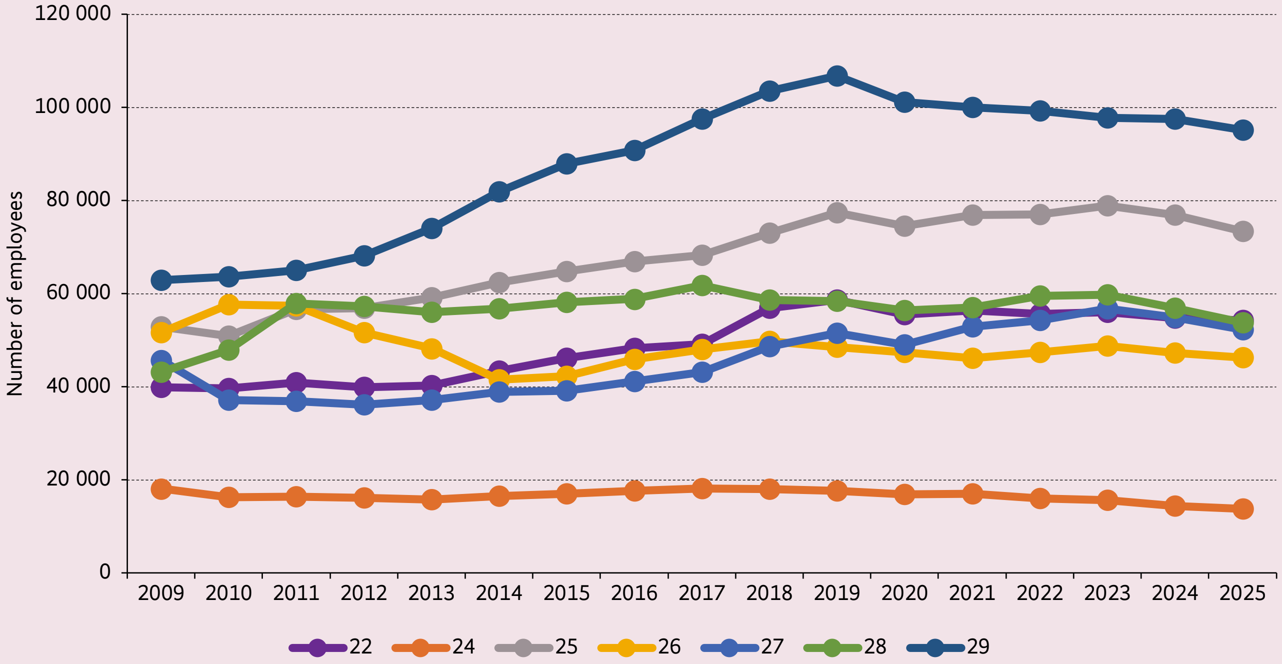
Volume indices of manufacturing and the analysed industries, 2009–2025 (2000=100%)



Source: Authors' compilation based on HCSO data

Fig. 16

Employees in manufacturing subsectors closely related to the automotive industry,[54] 2009–2025

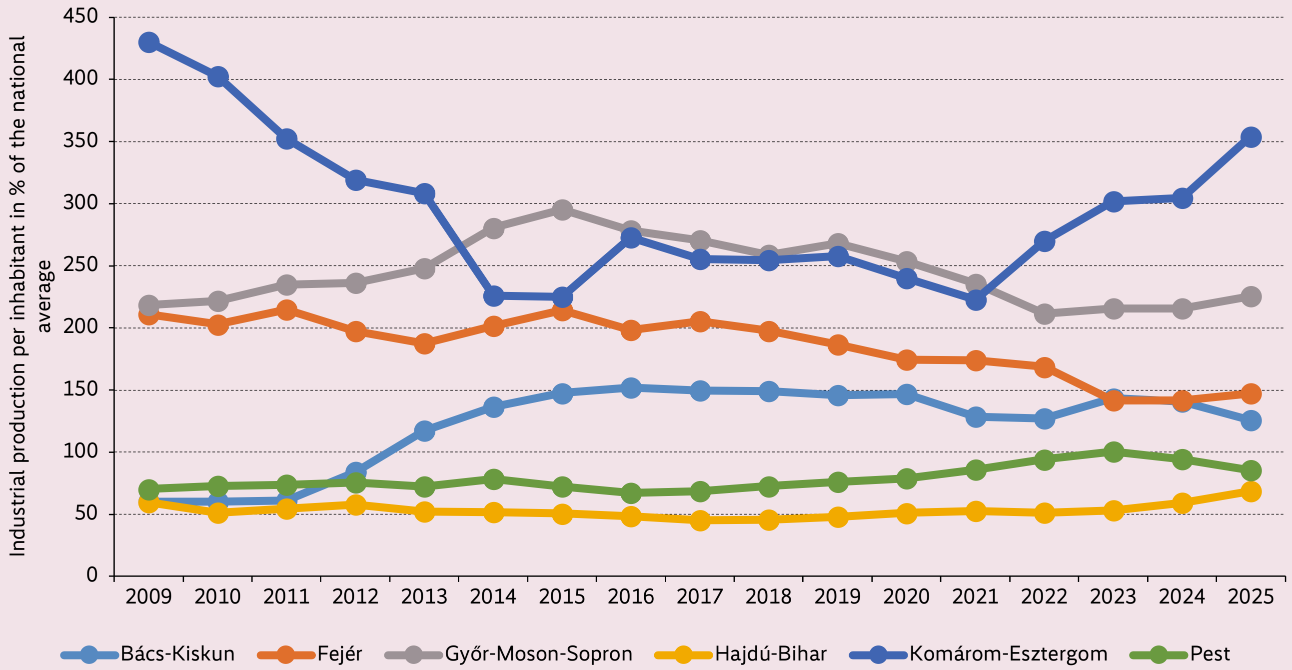


Note: 22: Manufacture of rubber and plastic products. 24: Manufacture of basic metals. 25: Manufacture of fabricated metal products, except machinery and equipment. 26: Manufacture of computer, electronic and optical products. 27: Manufacture of electrical equipment. 28: Manufacture of machinery and equipment n.e.c. 29: Manufacture of motor vehicles, trailers and semi-trailers.

Source: Authors' compilation based on HCSO data

Fig. 17

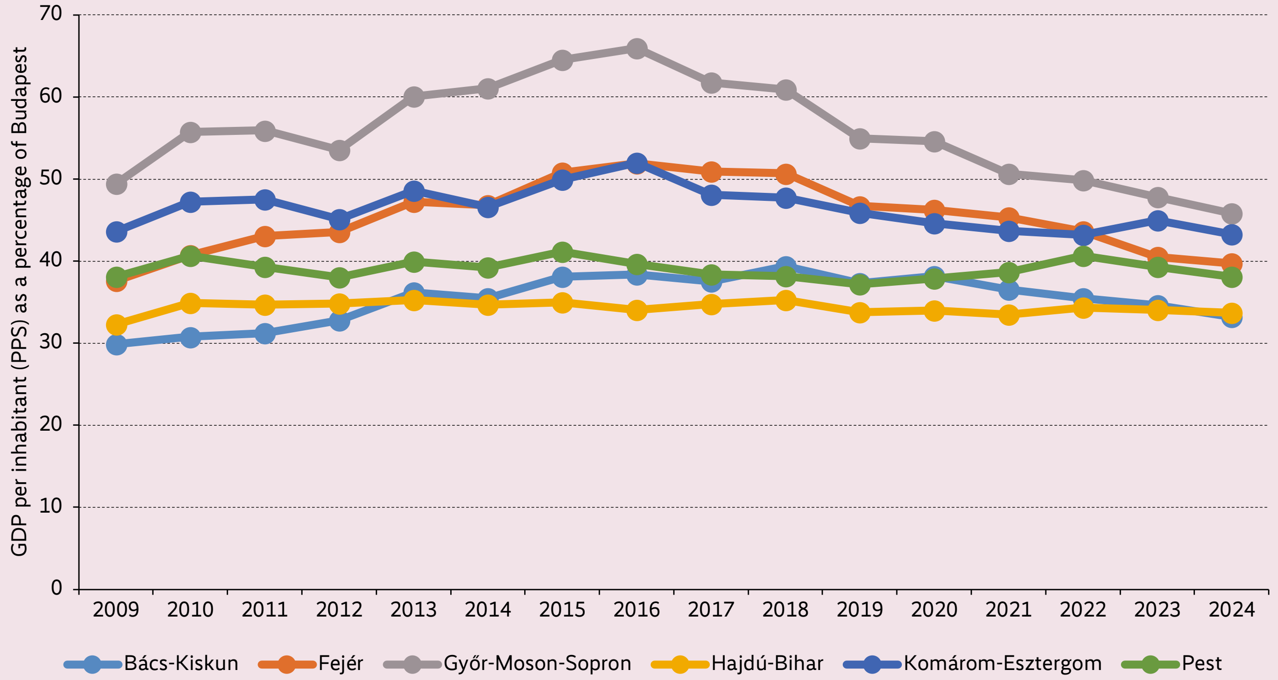
Industrial gross output per inhabitant in the key counties of the EV industry, 2009–2025



Source: Authors' compilation based on HCSO data

Fig. 18

GDP per inhabitant in the key counties of the EV industry, compared with Budapest, 2009–2024



Source: Authors' compilation based on HCSO data

Regional economic gains remain uneven and have not been translated into broader convergence. Counties hosting major automotive and battery plants have experienced significant increases in industrial output per capita (Figure 17). These gains have not translated into sustained convergence in terms of income levels, however, as regional GDP disparities relative to Budapest remain largely unchanged (Figure 18). This suggests that industrial expansion alone does not guarantee broader regional development. This is despite the fact that the relative position of the centres can change: Debrecen[54] is expected to supersede Győr as the second largest local economy after Budapest.

4.2 Domestic firms and upgrading

Despite the scale of new investments, the integration of domestic firms into EV-related value chains remains limited. Evidence from firm-level interviews[55] indicates that foreign investors – especially Chinese companies – tend to rely heavily on imported inputs and established supplier networks from their home countries. Key decisions regarding sourcing and production are typically made at headquarters level.[56] As a result, Hungarian firms are involved mainly in peripheral activities, often driven by regulatory requirements rather than genuine technological integration. (Only two firms were identified as supplying parts to the final product for a Chinese investment project.[57])

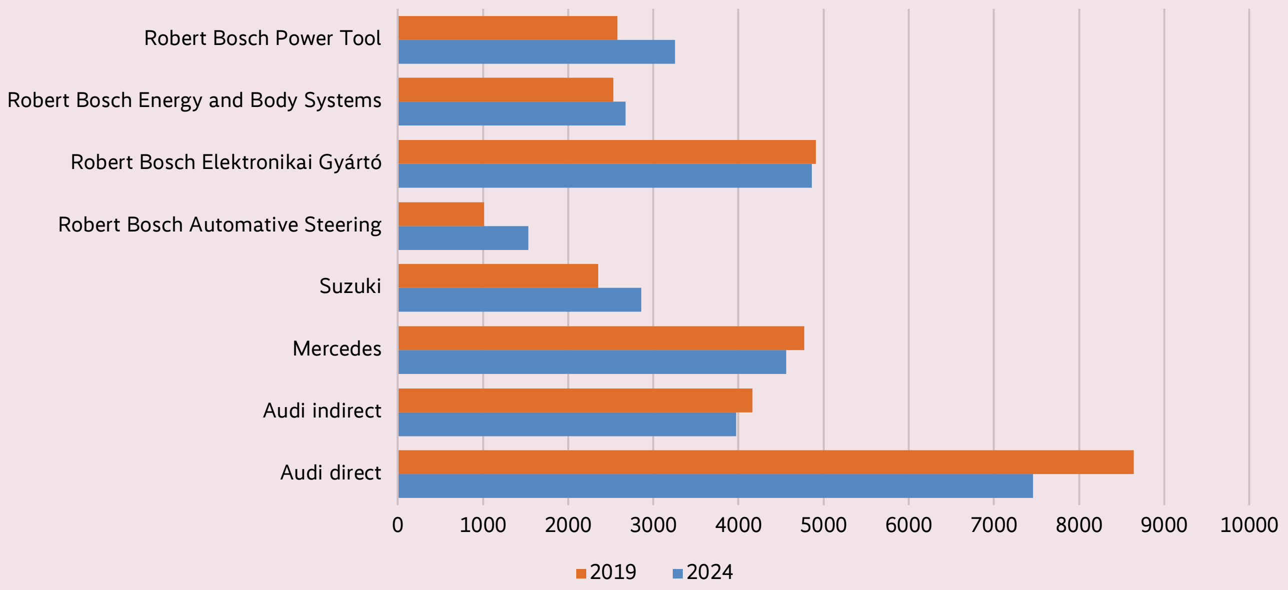
Several structural barriers hinder deeper upgrading. As already mentioned, Korean and especially Chinese investors have a closed, vertically integrated production model. On the other hand, domestic firms frequently lack the scale, technological capabilities and flexibility multinational investors require. The increasing automation intensity of EV and battery production further raises entry barriers for domestic suppliers, as participation increasingly requires advanced manufacturing capabilities, digital integration and substantial capital investments. In addition, differences in business practices and labour practices[58] and problems with communication create further obstacles. Public policy has so far played only a limited role in supporting domestic supplier upgrading. Structured programmes aimed at integrating Hungarian SMEs into EV-related value chains have been in place for a long time now, but remain underdeveloped, and existing initiatives – such as supplier forums – have had limited impact and can be considered to promote merely »symbolic« integration of Hungarian firms. This suggests that the EV transition has so far led to structural continuity rather than upgrading.

4.3 Labour and social impacts

The labour market effects of the EV transition are similarly ambivalent. On one hand, new investments have generated employment opportunities across a range of manufacturing and service activities, contributing to local economic dynamism in certain regions (Figure 20). On the other hand,

Changes in employment in the three OEM subsidiaries and the four Robert Bosch subsidiaries in Hungary, 2019–2024 (number)

Fig. 19



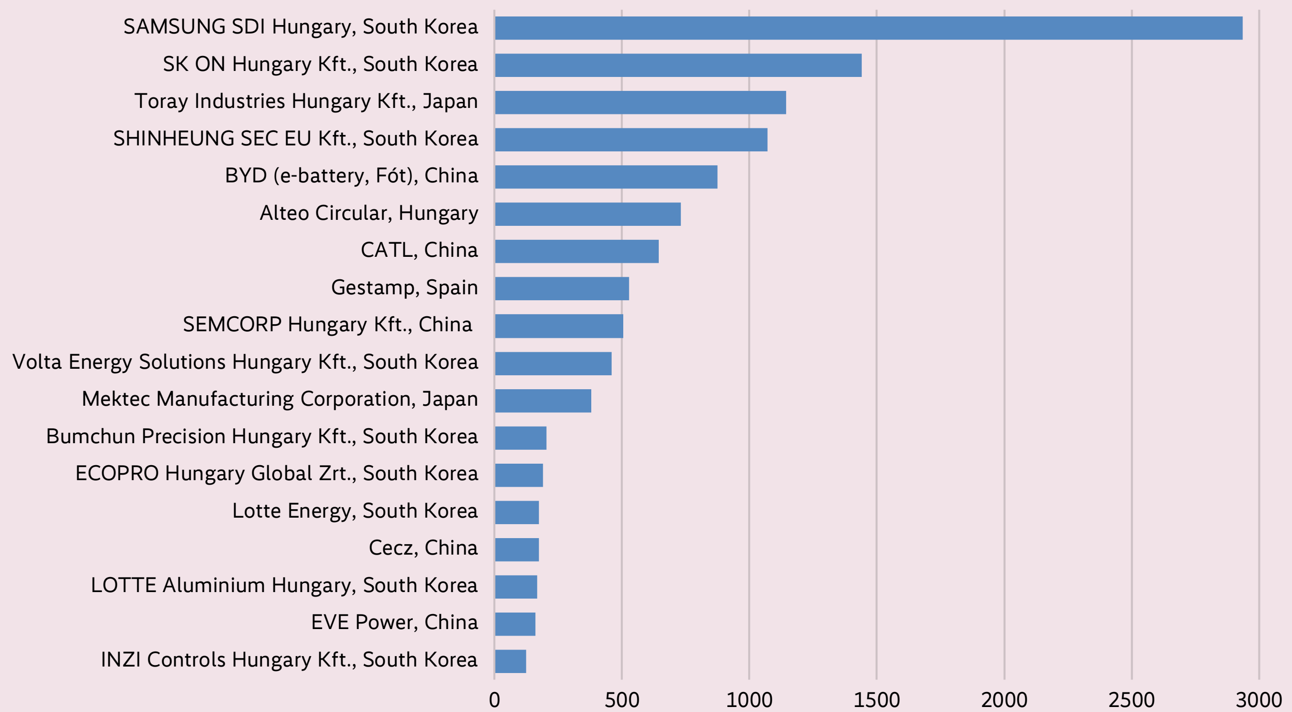
Note: Audi indirect refers to rented workers.
Difference between 2019 and 2024: −208 employees

Source: Supplementary annexes of company balance sheets

the sector's rapid expansion has intensified structural tensions. Loss of employment was far less than anticipated[59] (Figure 19). The resulting labour shortages have become more pronounced, particularly in regions hosting large-scale projects, while reliance on foreign workers, including Asian guest workers,[60] has increased.

Number of employees at the largest (more than 100 employees) e-battery factories, as of March 2025

Fig. 20



Note: Sum of the top 18: 11902.

Source: Supplementary annexes of company balance sheets

Furthermore, key high-skilled positions often remain concentrated within multinational companies and only home-country citizens can qualify for them.[61] This limits opportunities for local workforce upgrading and knowledge transfer. Anecdotal evidence suggests that Hungarian engineers working in Korean and Chinese battery factories frequently perform tasks below their level of education and qualifications.[62]

Wages in the sector are usually higher than the manufacturing average.[63] This partly reflects firms' attempts to attract scarce skilled – and in some cases even unskilled – workers from competing employers, while also being influenced by the disproportionately high salaries of expatriate managers.[64] At the same time, reports of labour rights violations have emerged concerning guest workers[65] (see Section 5 for more details). Differences in labour regulations, workplace practices and labour protection standards may also create tensions in the case of Hungarian workers and may limit collective agency.[66]

Social tensions have also intensified at the local level. Environmental concerns, infrastructure pressures and the limited involvement of local communities in decision-making have contributed to growing resistance to further investments. Rising housing costs (in Debrecen and Szeged real-estate prices soared as a consequence of the industrial boom; see Section 5) and uneven local benefits have further exacerbated these tensions. Cultural, social, communication and workplace tensions are documented between foreign managers, particularly those from Korea and China, guest workers, and local workers and residents.[67] These tensions may have contributed to growing public resistance and were also a factor in the results of the most recent elections.[68]

These developments indicate that the current model generates employment growth without broad-based social embeddedness, raising questions about its long-term sustainability and social acceptance.

4.4 Environmental impacts

The environmental implications of the EV transition represent one of the most critical challenges of the current development path. Battery production is highly resource-intensive, requiring significant inputs of energy, water and chemicals, while generating hazardous waste streams. In Hungary, these pressures are particularly pronounced because of existing resource constraints and the sector's rapid, policy-driven expansion. As of March 2026, roughly half of the 46 operational, or planned battery-related projects involved environmentally sensitive or hazardous processes, including electrolyte, cathode and cell production.[69] Documented cases of environmental incidents, regulatory shortcomings and infrastructure bottlenecks highlight the growing mismatch between industrial ambitions and ecological capacities. Evidence is abundant. South Korean firms operating in Hungary have several times violated environmental and industrial security regulations without suffering any serious consequences.[70] Numerous illegal procedures, accidents, noise, air and water pollution have been documented by local authorities and the press (see Section 5).[71] Chinese firms have also encountered problems, from as early as 2024, in the initial phases of production.[72] Incidents of pollution, irregular waste handling and dumping have further intensified public scrutiny.[73] The concentration of large-scale industrial projects in specific regions amplifies these pressures, creating localised environmental risks.

In tandem with this, the governance framework – characterised by accelerated permitting procedures and centralised decision-making – has limited the scope for effective local oversight and environmental control. As a result, the EV transition is associated with increasing environmental risks and governance challenges, which may undermine both local legitimacy and long-term sustainability.[74]

4.5 Energy, industrial and technological implications

Hungary's planned battery-production capacity could consume as much electricity as the country's only nuclear power plant currently generates. The projected energy demand of Hungary's planned 252 GWh battery-production capacity is estimated at around 16 TWh annually, roughly equivalent to the entire output of the Paks Nuclear Power Plant, usually supplies around 35 per cent of Hungary's electricity consumption.[75] In the late summer of 2026 the acticity of the Nuclear Plant had to be drastically reduced, almost stopped because of the record low level of the Danube. In EV battery factories, energy is used primarily for drying processes and for maintaining clean-room conditions, including strict humidity and temperature control. Thus, a stable and high-volume baseload power supply is essential. The key issue is grid stability: battery factories cannot simply be shut down temporarily; a continuous and uninterrupted electricity supply must be ensured at all times. Under current conditions in Hungary, this level of stability can be provided primarily by nuclear and gas-based energy generation.

Although the share of solar energy has increased significantly in recent years,[76] Hungary remains highly dependent on energy imports in terms of total primary energy consumption (including heating and fuels), with the import ratio fluctuating at around 60 per cent, mainly because of reliance on natural gas and crude oil.[77] The expansion of the battery industry is likely to further reinforce this dependence.

The emergence of EV-related industries introduces new technological domains and may create opportunities for diversification, particularly in areas such as electronics, materials science and energy systems. This is well demonstrated by the example of the University of Debrecen, at which a battery chemistry specialisation has been launched within the framework of the chemistry BSc major. However, the current organisation of value chains significantly limits such opportunities. Core technologies and strategic decision-making remain concentrated in the hands of lead firms,[78] while local activities are largely limited to production and assembly. The increasing importance of battery technologies – dominated by Asian firms – further reinforces external dependence in key segments of the value chain. As a result, knowledge transfer and capability-building are constrained. Regarding the integration of local suppliers the central role of technological capabilities can be expected: they attempt to integrate in EV value chains based on their existing capabilities (»metal components can be found in an EV as well«), which are expected to be more determinant because of the lack of experience in the production of new EV parts.[79]

Moreover, rapid technological change – such as shifts between battery chemistries or evolving supplier structures – adds an additional layer of uncertainty, potentially affecting the long-term viability of current investments. Taken together, these factors suggest that Hungary's position is characterised by technological upgrading at the sectoral level without corresponding upgrading at the national level.

4.6 Geopolitical and structural implications

Hungary's integration into EV-related value chains reflects a new form of structural positioning within the global economy. This important configuration is the combined result of multinational firms' strategic adaptation and the Hungarian government's proactive industrial policy, which seeks to position the country as a bridge between Eastern technologies and Western markets.

At the same time, these developments complicate broader EU ambitions for strategic autonomy. While EV investments expand production capacity within Europe, they also deepen Hungary's dependence on non-European firms, technologies and imported energy. Looming geopolitical tensions between the US and China or the EU and China raise concerns about the long-term sustainability of this strategy.

5. Case studies

In this section we examine selected case studies to illustrate how the emerging EV–battery–automotive cluster operates in practice and the extent to which it supports or constrains domestic upgrading. Rather than merely repeating the general patterns identified earlier, the cases highlight differences in firm strategies, governance structures and local impacts, and thereby provide a more nuanced understanding of Hungary's adaptive integration into EV value chains.

5.1 Debrecen cluster

Debrecen is Hungary's second largest city and a regional centre, but in the early 2010s its level of industrial development and overall economic performance were below the average of the country's other larger cities.[80] [81] [82] Although BMW was not the first automotive company to build a plant in Debrecen, this investment can be regarded as a turning point in the city's (re)industrialization. It started around 2014 and was accompanied by a narrative that characterised it as the »second capital city of Hungary«, promoted by both national and local government.[83] BMW »put Debrecen on the map« and the city seems to have become an automotive location of European dimensions, to which German and Asian companies have co-located and co-shaped the newly emerging EV production networks (Table 3).

Several factors contributed to the emergence of this complex EV automotive location in eastern Hungary. Pride of place should be given to large-scale development of industrial and transport infrastructure, including new industrial areas covering an area of more than 1,300 hectares with public utilities and a brand new railway terminal, led by the central state, as well as a workforce supplied by the city's excellent variety of secondary and tertiary education, underpinned by the region's relatively high unemployment rate. Other factors included agglomeration effects (and follow sourcing) arising from the importance of spatial proximity or just being within the EU because of local-content requirements and Debrecen's location in one of the least developed EU regions, which meant that it was entitled to the highest level of EU investment subsidies (50 per cent intensity) for firms investing there. As a result, the region of Debrecen (also including Nyíregyháza) shows the highest concentration of participants in battery value chains after Southeast China, with all steps represented except for mining.[84]

The newly established Automotive Cluster Debrecen (ACD) fosters regional embedding of EV companies by unifying (i) Western and Eastern, (ii) old and new, as well as (iii) transnational and domestic firms (iv) within and beyond the automotive production networks in the region of the city. ACD now represents 15 enterprises with more than 10,000 local employees. The cluster successfully lobbied for boosting the capacity of state-financed vocational training and developed joint materials to guide the renewal of education.[85] It also achieved an extension of public transport connections on the part of the state (MÁV-Volánbusz) and the municipal transport companies (DKV), and also a tariff community between state and municipal services.[86] In the near future, there will also be a truck park and a customs yard, as well as a bus station system with extended capacities around the BMW car plant. Most recently, so-called »artificial intelligence« (AI) and facility management seem to be emerging as potential new fields of intra-cluster cooperation.[87]

Table 3

German and Asian manufacturing firms in Debrecen, integrated in automotive networks

Company	Profile	Year of foundation*	Headquarters	Employment 09.03.2026 (planned)
BMW Manufacturing Hungary Ltd	2910 Manufacture of motor vehicles	2018	Germany	4,070 (unpublished)
Contemporary Amperex Technology Hungary Ltd	2720 Manufacture of batteries and accumulators	2022	China	643 (9,000)
EcoPro BM Hungary Inc.	2720 Manufacture of batteries and accumulators	2021	South Korea	189 (631)
Eve Power Hungary Ltd	2720 Manufacture of batteries and accumulators	2022	China	160 (440)
Halms Hungary Ltd	2453 Casting of light metals	2021	China	88 (300)
Schaeffler Debrecen Ltd	2815 Manufacture of bearings, gears, gearing and driving elements	1999	Germany	1,093
Schaeffler Motion Tech-nologies Debrecen Ltd (Continental/Vitesco)	2931 Manufacture of electrical and electronic equipment for motor vehicles	2018	Germany	1,103 (450+450)
Schedl Hungária Ltd	4520 Maintenance and repair of motor vehicles	2023	Germany	46 (60)
Semcorp Hungary Ltd	2221 Manufacture of plastic plates, sheets, tubes and profiles	2020	China	505 (440)
Thyssenkrupp Springs & Stabilizers Ltd	2593 Manufacture of wire products, chain and springs	2017	Germany	300 (250)
ZF Chassis Modules Hungary Ltd	2932 Manufacture of other parts and accessories for motor vehicles	2023	Germany	147 (230)

Note: * »Year of foundation« means the official establishment of the company or the start of its operations in Debrecen.

Source: Authors' compilation based on press materials, company databases and interviews.

Despite the positive initial results, the cluster is experiencing growing internal tensions because of a sense that Chinese battery producers do not really want to become integrated.[88] The cluster leadership is committed to keeping it together and so are trying to reach higher levels of management of Asian battery companies and broaden the cluster's joint European–Asian basis by inviting in further German, Chinese and Korean companies. Keeping all the relevant companies within the cluster can also make it a potential platform for handling the social and environmental problems connected with large-scale industrialisation and – in particular – battery production, which have given rise to local protests against the new investments.[89] [90] It remains to be seen how far ACD can support the local embedding of transnational companies in terms of suppliers. Not the direct connection with BMW as OEM but rather access to its tier 1 and tier 2 suppliers is regarded as the best way of enabling domestic suppliers to integrate in automotive networks.[91]

Debrecen is experiencing a double labour shock because of rapid industrial expansion. First, there has been a quantitative change – the scale of new jobs is disproportionate to the existing free workforce. There are currently about 32,000 manufacturing employees in the county. New industrial zones are set to create 20,000 additional positions. If these new roles are filled by local workers, it would effectively »drain« employees from established Hungarian manufacturing SMEs.[92] In order to cope with the tightness of the local labour market, several thousand guest workers have been employed in Debrecen.[93] The extent of restructuring is well illustrated by manufacturing employment's rising location quotient: while in 2018 the county of Debrecen (NUTS-3) had only the second lowest value (0.84) after Budapest among the 20 spatial units in Hungary, by 2025 it had exceeded the national average (1.00). But there has also been qualitative restructuring. The incoming Asian companies represent different industries and corporate cultures with different organisational mindsets compared with those traditionally present in the region.[94] This concerns the cultural dimension of their embedding. However, even Asian corporate strategies are different. Chinese company Eve Power communicates a higher share of well-educated Hungarian technicians and engineers and has established a battery testing centre in cooperation with the local university, while prioritising a more consistent embedding strategy based on local suppliers.[95] [96] [97] This at least has the potential to go beyond the above described »transplant« model.

5.2 South Korean investors in the EV battery sector

In 2017–2019 large-scale South Korean battery cellmakers (Samsung SDI and SK Battery) commenced production in Göd and Komárom. Under a new name, SK ON built two other factories in 2020 and in 2024. The EcoPro cathode material plant began production in 2025. Apart from these largest companies, there are several smaller South Korean supplier firms in the EV battery industry (including Soulbrain, Lotte, Volta Energy, Enchem, Sangsin, Bumchun, JWH and Dongwha). The SungEel Hitech battery recycling company opened plants in Szigetszentmiklós in 2019 and in Bátonyterenye in 2021. South Korean investors built up their own supply chain in Hungary early on, with base material or component producing, regenerating and recycling firms.

The biggest South Korean player is Samsung SDI, which established an EV battery factory on the site of its previous TV screen factory, close to the residential area of Göd. Samsung SDI obtained building permits from the local authorities in 2018, but no environmental impact assessment procedures were required even for successive expansion phases. The regional government authority required an environmental impact study and provided a permit only in 2023, when Samsung SDI announced further expansion. As it turned out, even the Hungarian government had been monitoring Samsung SDI's irregular practices in 2023 through its secret service, but decided against closing the factory.[98] Such practices continued, including problems with toxic NMP solvent leaks in water[99] or air,[100] toxic NMC powder inside the plant, under and on the roof,[101] and illegal hazardous waste exports requalified as »product«.[102] The South Korean SungEel plant was temporarily suspended in August 2023, but allowed to resume operations in spring 2024. SungEel treats Samsung's waste batteries in two Hungarian towns, where serious illegal practices have been documented by local authorities. Proof of this recycler's misconduct in Hungary were a major factor in the German protests in Rudolstadt and Gera and the factory's decision to withdraw its investment plans there.[103] SK Battery has also received several fines and has had problems with industrial safety.[104]

South Korean battery factories deliver to German carmakers. For example, Porsche announced a switch from CATL to Samsung in 2026.[105] In the relationship between BMW and Samsung SDI, a breakthrough in solid-state battery (ASSB) technology was achieved at the end of 2025/beginning of 2026 under a tripartite agreement with Solid Power (USA), which provides the technological basis and solid electrolyte. Samsung SDI develops cells from laboratory samples that can be manufactured on an industrial scale, and BMW validates the cells and installs them in test vehicles.[106] The expansion of the Göd plant is already under way to accommodate new-generation technologies (such as P6 prismatic cells and, later, solid-state solutions) so that mass production of solid-state batteries can begin in 2027. Thus, the Göd factory will supply BMW and also Volkswagen.[107]

The Hungarian Battery Association undertook the creation of the Korea–Hungary Battery Cooperation Centre (KHBCC), providing the legal and organisational framework for its operations. A small laboratory was established in 2026 for research and the investigation of material structural changes associated with the electrochemical ageing of battery cell components.[108] The lab coordinator told us that it is Hungarian, not Korean-financed. According to the professor responsible for the KHBCC, however, it is still in the planning phase.[109]

5.3 BYD

BYD's Hungarian bus assembly plant in Komárom started production in 2017 and plans to triple local capacity to 1,250 units annually, with the »customary« 10 per cent state support (Figure 11).[110] [111] BYD also moved its European headquarters to Budapest to centralise its operations in the country.[112] The largest investment, however, is the BYD factory in Szeged, the first passenger car factory built by a Chinese company in Europe. The EUR 4 billion project was announced in December 2023 and trial production began in January 2026. Initial capacity will be 150,000 vehicles, with plans to scale up to 300,000 units annually.[113] By manufacturing in Hungary, BYD can bypass EU import tariffs on Chinese-made vehicles and access the EU market and also markets with free trade agreements with the EU if it reaches the required local-content level. However, in early 2026 a video came to light from inside BYD's EV factory showing cars arriving from China, only to be disassembled and then reassembled on site.[114] The likely aim of this process seems to be to qualify the vehicles for the »Made in EU« label. In April 2026 BYD applied to join the European Automobile Manufacturers' Association (ACEA).[115]

To date, the project has had mixed effects on the city. Szeged is a regional centre, at the intersection of two motorways. A new track will link the Szeged–Subotica line to the Budapest–Belgrade corridor, providing a direct route to Adriatic ports or, potentially, Piraeus. BYD and local officials emphasise that there will be no battery production on-site, only storage. A local poll in 2024 showed that 85 per cent of local people support the factory, with only 10 per cent against.[116] The image of BYD cars is good in Szeged and the investment has brought the city worldwide fame.[117] The company rarely communicates publicly, and even then only after coordination with headquarters in China.[118] One important side-effect of the investment is that real-estate prices in the city have increased significantly. This is a problem for students in Szeged, but a positive development for the many residents who rent out apartments.[119]

The BYD factory was built extremely rapidly on a 300-hectare industrial site, using imported Chinese materials.[120] Chinese workers live in containers on site. A study published by the China Labor Watch organisation describes labour rights violations, including excessive working hours, seven-day workweeks, visa irregularities and opaque wage practices.[121] The document reveals that many workers are subjected to recruitment-related debt and the withholding of wages, which are internationally recognised indicators of forced labour.

BYD production clearly poses a challenge for European carmakers. In March 2026, BYD's registrations in Germany surged by 327 per cent, year-on-year.[122] How BYD achieved this price and technology advantage has already been thoroughly analysed.[123] One important factor is that BYD is a leading battery producer, owns lithium mines and has built a car »around the battery«, producing everything in-house, including semiconductors, motors, windshields, headlights and software.[124] BYD developed plug-in hybrids, useful in China where charging stations are rare outside the big cities. In 2020, BYD released the Blade Battery, lithium iron phosphate (LFP), which was cheaper, safer and longer lasting, enabling BYD to sell cars at a lower price. Apart from internalising the whole production chain, BYD received huge direct subsidies from the Chinese state, allowing it to sell below cost for years. BYD also obtained the raw materials at a much lower price, as well as preferential loans and cheap land for factory construction, and benefitting from purchase incentives offered to Chinese buyers, as its models were the most popular.[125]

In early 2025, however, it turned out that BYD's debt is much higher than officially reported, because it pays its suppliers late, issuing promissory notes.[126] BYD also sells thousands of brand-new cars to its own shell companies, then resells them as »used, zero kilometres«, which means that on-paper new car sales end up parked across China.[127] Partly because the Chinese authorities began to crack down on these practices and partly because of strong competition, BYD's position in China has been undermined.[128] This explains the high importance of the European market and the rapid establishment of production in Hungary.

6. Conclusions and policy implications: Hungarian, European and German perspectives

6.1 Hungary's repositioning

This paper highlights a central paradox. Hungary's EV–battery–automotive transformation represents a rapid adaptation to the structural changes reshaping the global automotive industry. By actively attracting both German OEMs and Asian battery producers, the country has managed to preserve and even strengthen its role within European automotive value chains. The co-location of these actors has created a new industrial ecosystem that links European production and markets with Asian technological capabilities. This positions Hungary as one of Europe's leading EV-related production locations. At present Hungary occupies a specific intermediary position in a triangle with Germany and Asia. In this structure, Germany provides demand, traditional technology and value chain governance; Asia supplies key technologies and inputs; while Hungary offers production capacities and an enabling institutional environment.

At the same time, this transformation appears to reflect a form of strategic overshooting, in which the attraction of EV and, especially, battery-related capacities has exceeded the country's infrastructural, environmental and institutional absorption capacities. Furthermore, it has largely reproduced the core characteristics of Hungary's earlier development model. Foreign ownership, external technological dependence, weak domestic embeddedness and limited local value capture remain defining features of the emerging EV cluster. Rather than bringing about a fundamental transformation of Hungary's position in global value chains, the EV transition has resulted in a reconfiguration of dependencies, with Asian firms increasingly complementing the previously dominant German-centred production networks.

The current model therefore combines clear short- and medium-term advantages with growing structural vulnerabilities. It has strengthened industrial output, export capacities and strategic relevance within Europe, but it has also generated overspecialisation, rising fiscal and environmental costs, increasing resource pressures and growing geopolitical exposure. The rapid and large-scale nature of the expansion has amplified these tensions.

This is the situation the new government under Péter Magyar has inherited, and the key challenge now is to manage it in a way that minimises its costs and negative side effects while maximising its potential benefits for the Hungarian economy.

6.2 Opportunities and constraints of domestic upgrading

The Hungarian case demonstrates that integration into technologically advanced sectors does not lead automatically to upgrading at the national level, as domestic firms may remain only weakly integrated in the new value chains. Existing patterns of limited supplier integration and modest knowledge transfer persist, especially in the case of vertically integrated Asian investors, which rely heavily on imported inputs and established home-country supplier networks. However, opportunities do exist for selective upgrading. Existing engineering capabilities, accumulated automotive experience and the growing presence of EV-related activities may create possibilities for domestic firms and institutions to strengthen their positions in selected niches, particularly in engineering services, specialised manufacturing, automation, electronics, maintenance, recycling and battery-related research. Whether these opportunities materialise depends heavily on public policy, industrial policy, institutional coordination and long-term capability-building efforts.

6.3 Managing the existing model: from rapid expansion to embedded development

The central challenge is no longer whether Hungary should integrate into EV-related value chains, as this integration has already taken place. The more relevant question is how the country can maximise the benefits of the current model while reducing its negative side effects and vulnerabilities.

This requires a partial shift in industrial policy priorities, from rapid capacity expansion towards deeper domestic embeddedness, sustainability and resilience. Several policy areas appear to be particularly important.

First, policies on supplier development and upgrading should play a much stronger role. Targeted programmes supporting domestic firms' technological upgrading, certification, engineering capabilities and integration into EV-related value chains could strengthen local value capture. Investment incentives should increasingly be linked to local sourcing, supplier development, R&D cooperation and knowledge transfer.

Second, industrial policy should be more closely coordinated with environmental, energy and infrastructure policies. The future expansion of battery-related industries needs to be aligned with realistic assessments of water availability, electricity supply, grid stability and environmental carrying capacities. Strengthening regulatory oversight, transparency and local participation could reduce social conflicts and improve legitimacy. Intensifying local R&D efforts to minimise negative environmental effects is of crucial importance (and may provide local firms with a competitive advantage, even internationally).

Third, labour market and education policies need to be adapted to the changing structure of the industry. Expanding engineering, technical and vocational training capacities, while improving working conditions and labour protections is essential for strengthening local capabilities and reducing labour market tensions.

Fourth, diversification remains important in order to reduce excessive dependence on a single industry and on a narrow group of foreign actors. Supporting related (or even slightly related) sectors and technologies beyond battery assembly may strengthen long-term resilience.

6.4 At European level

The Hungarian case also points to broader European challenges. In the foreseeable future, it is likely that European electrification will continue to rely heavily on Asian battery technologies and know-how. Under these conditions, the key issue may not be whether dependence can be fully eliminated, but whether Europe – and individual countries such as Hungary – can gradually increase local capabilities, bargaining power and value capture within an inevitably interdependent system. These developments will unfold within an increasingly intense US–China–EU geoeconomic competition, in which EV and battery industries have become strategic areas of industrial policy and technological rivalry. In this triangular competition, Europe occupies an intermediate position, being technologically advanced in several traditional areas, but dependent on external actors in critical EV-related technologies.

The Hungarian case illustrates particularly clearly that expanding production capacities within the EU translates automatically into neither technological sovereignty nor technological leadership, especially when these capacities rely on technologies and inputs that Europe does not control. It also highlights the risks of intensifying subsidy competition among Member States in an era of declining global FDI availability, potentially distorting resource allocation and weakening EU-level coordination. These dynamics are especially relevant for Central and Eastern European economies, which still rely heavily on industrial FDI while remaining largely concentrated in lower value-added and resource-intensive activities. This common standpoint is well reflected in the most recent attempts by automotive associations in V4 countries and Romania to create a common platform (CEE AutoHUB) for interest representation.[129]

Hungary occupies a particular intermediate position within a Germany–Hungary–Asia triangle: Germany provides demand, traditional production and value chain governance; Asia supplies key technologies and inputs; and Hungary offers certain production capacities and an enabling institutional environment. While this intermediary role facilitates rapid integration into emerging industries, it is also associated with persistently low domestic value capture, exposure to external shocks and limited opportunities for technological upgrading.

Overall, Hungary's EV transition demonstrates that rapid industrial adaptation is possible even under conditions of structural dependence. However, without stronger domestic capability-building, supplier upgrading and better coordinated industrial policies, this adaptation may remain locked into a »low-road« development path based on cost competitiveness, subsidies and external dependence.
The key challenge is therefore not integration itself, but transforming integration into more embedded, innovation-driven and sustainable development.

A number of interrelated policy implications emerge on this basis. At the EU level, there should be closer coordination of industrial policy instruments to avoid harmful competition for subsidies. Building European technological capabilities

– especially in batteries and related areas – should be made a priority to remain competitive vis-à-vis both US and Chinese actors. Furthermore, external dependencies should be reduced without undermining the openness of the EU Single Market.

6.5 From a German perspective: adaptation under structural pressure

German automotive firms remain central actors in shaping Hungary's transformation. Their strategies exhibit a form of dual adaptation, maintaining production within the lower-wage part of the EU to secure market access, while increasingly relying on external, mainly Chinese and Korean partners for key EV and battery technologies. Hungary plays a strategic role in this model, offering a cost-efficient production location within the EU and a platform for integrating Asian suppliers into European production networks.

This model gives rise to a number of structural tensions, however. First, it entails a shift in technological control outside Germany and the EU. Second, competitiveness pressures are increasing as Chinese EV producers combine cost advantages with rapid technological upgrading, challenging the traditional German model. Third, supply chain vulnerabilities are growing. More specifically, dependence on Chinese markets and technologies creates geopolitical risks, which are further amplified by potential transatlantic regulatory divergence and politics, industrial policy and trade policy shifts. In this sense, investments in Hungary are a result not only of industrialisation of the periphery, but also of a spatial reconfiguration of the German industrial model under transition pressures shaped by global competition.

6.6 Economic policy recommendations for maximising the benefits and minimising the costs of Hungary's specialisation in EV batteries

The most effective approach would be to develop a comprehensive strategy for the economy as a whole and position the sector within this broader framework. At the same time, there are several recommendations that could also be implemented in the shorter term.

1. As a first step, a comprehensive assessment of the Hungarian battery industry should be conducted.

This should include a thorough review of the contracts concluded with the battery factories, as well as a broad-based expert evaluation involving economists, water management specialists, soil scientists, environmental experts, air quality engineers, chemists, waste management and industrial safety experts, trade unions, local civil society organisations, representatives of the Battery Association, and legal experts. In addition, climate scientists, forecasters and modelling experts should also be involved, as climate change raises serious uncertainties regarding the long-term availability of water resources.

Such an assessment could help to determine the extent to which Hungary will be able to accommodate further battery-related investments, identify the country's environmental and infrastructural limits, and evaluate the likely economic, social and ecological consequences of continued expansion.

2. Slow down and sequence further capacity expansion.

New and ongoing investments should be aligned with electricity grid development, water availability, transport infrastructure, labour market capacity and environmental monitoring capacity.

3. FDI incentives should be linked more closely to local embeddedness.

For example targets may include local supplier development, cooperation with Hungarian SMEs, training commitments, R&D activities and cooperation with companies, universities and institutes, environmental performance and even local procurement targets (if regulations allow).

4. Develop a Hungarian and regional supplier strategy.

Supplier development policies should focus primarily on tier-1 and tier-2 integration opportunities rather than direct OEM integration. Furthermore, international cooperation may help in obtaining access to supplier opportunities in neighbouring countries. Industrial policy tools may include funds for upgrading suppliers, technical certification support, development of engineering capabilities, support with exports and regionalisation, and cluster-based matchmaking programmes. In accordance with the argument of this paper, existing Hungarian capabilities in metal processing, plastics, industrial tooling, safety and inspection equipment, and industrial automation, as well as firms with related R&D capacities can be targeted.

5. CEE automotive strategy.

In accordance with the previously mentioned regional approach, the CEE countries could cooperate more systematically in supplier integration, logistics, specialised production niches, workforce training and building innovation networks. The CEE AutoHUB initiative could evolve into a regional platform supporting the internationalisation of local suppliers across the region.

6. Battery recycling.

Given the already high stock of related capacities, battery recycling represents one of the few areas in which local upgrading opportunities may still emerge. Support may be given to domestic recycling capabilities, and Hungary can attract EU-supported recycling investments, create recycling innovation programmes and develop specialised environmental technologies. At the same time, strict environmental safeguards are essential because recycling is highly energy-, water- and chemical-intensive. This may play an important role in winning back trust in such activities.

7. Reduce energy vulnerability.

The battery industry substantially increases Hungary's electricity demand and exacerbates its dependence on imported energy. The government should take targeted measures to reduce this vulnerability.

8. Investment in education and engineering capacity.

In order to meet the increased needs, it will be necessary to expand engineering education, strengthen vocational training, support dual education, develop specialised EV and battery curricula, and introduce retraining programmes and incentives for STEM careers.

9. Strengthen universities.

Universities should not function merely as labour suppliers for multinational companies. In accordance with the abovementioned more intense cooperation, their role should include applied research, testing facilities, innovation support, environmental monitoring, start-up incubation and local development planning through increased public policy support for university–SME cooperation, domestic innovation ecosystems and independent research capacities.

10. Improve labour standards and worker representation.

As described in this paper, the current model risks creating a fragmented and precarious labour structure that is heavily dependent on migrant workers (at least in certain regions). This problem can be addressed through stronger labour inspection, improved occupational health monitoring, support for collective bargaining, strengthening trade unions, transparent employment standards for subcontractors, and housing and integration support for foreign workers (if they are allowed to come to ease labour shortages). Training should be developed for labour inspectors, industrial safety specialists and environmental protection specialists.

11. Stronger environmental governance.

We have described, on one hand the potential risks, and on the other, actual cases in which environmental damage has been done. We assume that more frequent unannounced inspections, heavier penalties, stricter enforcement of environmental standards, transparent emissions monitoring, independent environmental audits, mandatory public reporting, stricter water use regulation and compulsory BAT standards could help to improve the situation. Firms that use resources at a level well above the local average should contribute to the related costs (including water management and local environmental rehabilitation).

12. Increasing (winning back) trust.

Transparent monitoring systems, publicly accessible environmental data, regular independent scientific assessments accessible to all community consultation mechanisms, local development agreements and intercultural programmes may help to enhance trust. Local initiatives such as intercultural community centres in Debrecen illustrate how municipalities can mitigate tensions connected to rapidly growing foreign workforces.

13. Upgrading over the longer term.

Over the longer term, the government should aim to reduce excessive dependence on assembly-type activities, diversify industrial structures, increase domestic innovation capacities, strengthen local ownership and support technologically capable Hungarian firms. Existing battery capacities and the EV transition should be used to promote broader industrial upgrading and greater technological autonomy.

14. Support measures at the EU level

At the EU level, a more coordinated industrial policy framework would be necessary to avoid destructive competition for subsidies and excessive concentration of capacities in a few production locations. The Hungarian case illustrates a broader European dilemma: while EV investments contribute to Europe's green transition, they also deepen dependence on non-European technologies and firms, especially Asian battery producers. Therefore, the EU should place greater emphasis on supporting European-owned battery technologies, scaling up EU-based recycling capacities, securing critical raw materials, investing in next-generation battery technologies and strengthening European R&D ecosystems.

Table 4

Interviews conducted

No.	Type	Role/affiliation	City/county
1	Municipal	Senior municipal official	Szeged
2	Corporate	Senior manager, Chinese battery manufacturer	Debrecen
3	Civil society	Environmental NGO representative	Debrecen
4	Civil society	Civic association member	Szeged
5	Academic	Ecological economist, university	Szeged
6	Municipal	Industrial park management company	Debrecen
7	Municipal	Economic development agency	Debrecen
8	Corporate	PR managers, Chinese battery cell manufacturer	Debrecen
9	Corporate	Tier-3 supplier, Hungarian	Debrecen
10	Corporate	Automotive Cluster representative	Debrecen
11	Academy	KHBCC laboratory director, chemistry professor	Budapest
12	Academy	Chemistry professor, KHBCC, Hungarian Battery Association	Budapest
13	Corporate	Representative of a consultancy company	Borsod-Abaúj-Zemplén county
14	Municipal	Former representative of the Economic Development Agency	Debrecen
15	Association	Representative of automotive association	Budapest
16	Corporate	Hungarian supplier to Chinese e-battery firms	Budapest
17	Corporate	Potential Hungarian supplier to e-battery firms	Fejér county
18	Corporate	Potential Hungarian supplier to Chinese e-battery firms	Bács-Kiskun county
19	Corporate	Supplier to Chinese e-battery firms	Budapest
20	Corporate	Supplier to Chinese firms	Budapest

Endnotes

1 The authors are grateful to Ernst Hillebrand for his comments on an earlier version of the paper. They are thankful also to Thembi Madalane for her provision of Chinese language sources.

2 https://autopro.hu/gyartosor/europa-legnagyobbjai-kozott-a-kecskemeti-mercedes-gyar/1534186

3 Bosch operates one of its largest European engineering centres in Budapest (https://www.bosch.hu/en/our-company/bosch-in-hungary/budapest-robert-bosch-kft/); the Austrian AVL, an independent automotive R&D firm, has developed a significant R&D presence (https://www.avl.com/en/locations/avl-hungary-kft); and firms such as Audi, Mercedes, Thyssenkrupp and Continental have located development-related activities in Hungary. Another aspect of upgrading is represented by BMW's new service centre in Debrecen, providing logistic and financial services for other BMW plants as well (https://hipa.hu/hir/BMW-Debrecen-HIPA-BSC-beruhazas/).

4 https://battery-news.de/batterieproduktion/

5 https://autopro.hu/elemzesek/egysegben-az-ero-regionk-jarmuipara-egyutt-meg-nemetorszaggal-is-versenykepes/1568644

6 According to the International Organization of Motor Vehicle Manufacturers (OICA), Hungary is the 21st largest car producing country in the world and it has the 5th highest per capita production in Europe. It is a leading producer and exporter of internal combustion engines, diesel engines and engine parts (see trademap.org). Considering also the capacities of Japanese Suzuki (nearly 160,000 cars produced in 2023) and Chinese BYD (150,000 car/year) which started the test production at its Szeged plant in February 2026, together with the abovementioned production of the three German subsidiaries, Hungary, under advantageous global economic conditions, has the chance to produce 1,000,000 cars/year by the end of this decade, most of which will be exported. (See https://www.vg.hu/vilaggazdasag-magyar-gazdasag/2024/06/suzuki-hany-auto-keszul-esztergomban ,https://autopro.hu/gyartok/a-szegedi-byd-hatasa-mar-a-hataron-is-latszik/1544976 , https://autopro.hu/elemzesek/a-technologiai-semlegesseg-a-magyar-jarmuipar-sikerenek-kulcsa-a-mage-szerint/1561940)

7 In the absence of data we assume that in NACE 27, German FDI is concentrated not in e-battery, but in other electrical equipment related activities.

8 Molnár E., Kozma G., Mészáros M. and Kiss É. (2020): Upgrading and the geography of the Hungarian automotive industry in the context of the fourth industrial revolution, Hungarian Geographical Bulletin 69 (2): 137–155. In this article a »duality« is described, which refers mainly to the simultaneous processes of spatial concentration and expansion within the Hungarian automotive industry: concentration of strategic, innovation-intensive and control functions in core regions, and expansion of production activities into peripheral areas.

9 There are contrasting views in the literature considering the position of these countries in the European automotive industry, but there is agreement that Czechia and maybe Poland, while are still on the periphery, may soon achieve semi-periphery status, while Hungary and especially Slovakia – with some semi-peripheric features – remain still essentially part of the periphery based on the activities carried out, at the level of foreign dependence and local value capture. Pavlínek P. (2025) The Core–Periphery Structure of the European Automotive Industry, in: Europe's Auto Industry: Global Production Networks and Spatial Change. Development Trajectories in Global Value Chains, Cambridge University Press, pp. 94–124, https://doi.org/10.1017/9781009453196.006; or Szalavetz A. and Sass M. (2023) Disentangling the semi-periphery: evolutionary trajectories and perspectives of the Austrian and Hungarian automotive industries, Post-Communist Economies 35(3): 211–235, https://doi.org/10.1080/14631377.2023.2171179

10 Gáspár T., Sass M., Vlčková J. and Koppány K. (2023) Changes in automotive value chain participation on the integrated periphery – The case of Czechia and Hungary, Society and Economy 45(3): 335–354, https://doi.org/10.1556/204.2023.00003

11 https://www.agora-verkehrswende.org/fileadmin/AutomaticFiles/1193/Abb-06.pdf

12 Martišková M. and Lukáčová K. (2024) Slovakia as an Automobile Superpower or Factory Economy?, in : Michael Augustín, Peter Jančovič and Bruno S. Sergi, Modeling Economic Growth in Contemporary Slovakia, Emerald. https://doi.org/10.1108/9781835494547

13 Based on Eurostat and KSH data, the automotive industry accounted for nearly 9 per cent of total output and more than 3 per cent of value added in 2024 in the total economy, while vehicles represented more than 15 per cent of Hungarian exports in 2025. More than 90 per cent of sales are realised abroad, indicating a high export intensity of production. Subsectors 29–30 (manufacture of transport equipment) and subsector 27 (manufacture of electrical equipment) represent 43 per cent of manufacturing exports and 35 per cent of production in 2025. Germany absorbs more than 30 per cent of vehicle exports, followed by other EU Member States, Turkey and the United States. Despite its heavy macroeconomic weight, the sector is highly concentrated in terms of the number of companies.

14 Further important players came from Japan and the US in 2023. China was represented by just eight firms at that time, based on FATS data of the Hungarian Central Statistical Office.

15 https://www.ksh.hu/s/kiserleti-statisztika/kiadvanyok/erteklanchossz-es-teruleti-koncentraltsag-a-jarmuiparban/ Data refer to 2023; since then, due to the new capacities, shares may be significantly higher. Similarly, R&D activities in the motor vehicle industry often appear beyond the statistical borders of the sector: German companies such as Bosch or Thyssenkrupp employ several thousand people registered in the R&D sector. See https://www.ceginformacio.hu/cr9310017920 and https://www.ceginformacio.hu/cr9315947054

16 Trade in terms of value added, which does not include double/triple/more counted parts and components and indicates domestic value added in exports. See https://www.oecd.org/en/topics/sub-issues/trade-in-value-added.html

17 See also Braun, E. and Cseporán, Zs. (2025) A magyar gazdaság semlegessége. Elemzés a bilaterális kapcsolatok tükrében [The neutrality of the Hungarian economy. Analysis in terms of bilateral relations], Statisztikai Szemle, https://doi.org/10.20311/stat2025.04.hu0309

18 Building on the 2019 European Green Deal and the Fit for 55 package, the EU regulatory framework has been expanded by means of new industrial policy instruments, including the Net-Zero Industry Act, which aims to strengthen domestic clean-technology production capacities, and the Clean Industrial Deal, which places decarbonisation, competitiveness and strategic autonomy at the centre of EU industrial policy.

19 Notably, the 2035 ban on internal combustion engines was reduced to a 90 per cent reduction in late 2025, reflecting a pragmatic adjustment to technological realities. https://www.europarl.europa.eu/doceo/document/E-10-2025-003983_EN.html

20 Hira, A (2025) The geopolitics of the green transition and critical Strategic minerals, International Journal, 80(2): 217–245. DOI: 10.1177/00207020251332595

21 Gstöhl, S and Schnock, J. (2024) Towards a Coherent Trade-Environment Nexus? The EU's Critical Raw Materials Policy, Journal of World Trade 58(1) (January): 35–60. https://doi.org/10.54648/TRAD2024002

22 https://www.miningsee.eu/strengthening-strategic-minerals-diplomacy-europe-engages-with-latin-america-and-africa/

23 The Industrial Accelerator Act is intended to reduce administrative burdens and promote the »Made in EU« mark by fast-tracking permits. The list of European Strategic Projects, grants »outstanding public interest« status to key ventures, capping permit timelines at 15–27 months. https://single-market-economy.ec.europa.eu/publications/industrial-accelerator-act_en

24 Simonazzi, A. (2025) The bumpy road of the European automotive industry towards sustainable mobility, . Rendiconti Lincei 36: , 417–428. https://doi.org/10.1007/s12210-025-01314-8

25 For decades, Hungary has relied on FDI to drive growth, employment, exports and industrial restructuring. The expected benefits – including technology transfer and supplier upgrading – have been only partly realised, however (see, for example, Gál, Z. and Lux, G. (2022) FDI-based regional development in Central and Eastern Europe: a review and an agenda, Tér és Társadalom 36(3): 68–98; Sass, M. (2021) FDI-based models and what the future may have in store for them, WIIW Monthly Report 2: 18–26).

26 https://hungarytoday.hu/hungary-on-the-way-to-become-the-second-largest-producer-of-electric-batteries/ Other factors included the Orbán government's deliberate shift towards non-EU markets and FDI (»Eastern Opening«) and the fact that new (greenfield) FDI was available mainly in EV-related industries.

27 Ricz, J. and Éltető, A. (2025) Paradoxes of Green Transition and Developmentalism: The Case of EV Battery Production in Hungary, Problems of Post-Communism 72(6): 528–542. https://doi.org/10.1080/10758216.2025.2459268

28 Even the forecasts proved to be overstated: job losses related to the EV transition in Hungary were far more limited than initially predicted. According to our calculations, based on company-level data, the combined number of employees at the three OEMs (Suzuki, Audi and Mercedes) and the four Robert Bosch subsidiaries was only 208 lower in 2024 than in 2019, pre-COVID (see Figures 19 and 20).

29 https://hu-ba.hu/wp-content/uploads/2024/01/Hungarian-National-Battery-Industry-Strategy-2030_ENG.pdf

30 Éltető, A. (2024) Why Is It Different? Specific Characteristics of the Hungarian Battery Industry: Legal Background and Environmental Impacts, HUN-REN Centre for Economic and Regional Studies, Institute of World Economics, Working Paper No. 276.

31 Estimations in April 2025 put the direct and indirect costs of attracting e-battery firms at around EUR 4 billion, the equivalent of 2 per cent of GDP. https://www.intellinews.com/hungary-channels-close-to-4bn-in-subsidies-to-ev-battery-industry-377434/ This amount may have grown further since then.

32 Ricz, J., and Éltető, A. (2026) Rules for sale: autocratic forbearance, as a new industrial policy tool to promote the Hungarian battery hub, Journal of Economic Policy Reform, 1–29. https://doi.org/10.1080/17487870.2026.2680291

33 For example, in the case of environmental impact assessment, the deadline is sixty days for a single environmental use permit procedure, and 90 days in the case of a consolidated procedure. The law contains further simplifications in land procedures, investments in transport infrastructure, and court proceedings related to the issue of permits. https://njt.hu/jogszabaly/2023-100-00-00 chapter 42.

34 Lechowski, G. and Weis, N. (2025) The German Industrial Model in Transition: Electromobility Challenges in the Automotive Sector, in: Krzywdzinski, M., Lechowski, G., Humphrey, J. and Pardi, T. (eds) Global Shifts in the Automotive Sector. Palgrave Studies of Internationalization in Emerging Markets, Palgrave Macmillan. https://doi.org/10.1007/978-3-031-80641-4_6

35 Lechowski, G. and Weis, N. (2025). See n 34 above.

36 https://autoworldjournal.com/german-auto-industry-battles-ev-shift/#:~:text=The%20situation%2C%20described%20as%20a%20%E2%80%98German%20polycrisis%E2%80%99%20by,EVs%2C%20and%20stiff%20competition%20from%20emerging%20global%20players

37 https://www.batterytechonline.com/market-analysis/how-east-west-collaboration-can-build-a-more-resilient-battery-supply-chain

38 https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/european-automotive-industry-what-it-takes-to-regain-competitiveness

39 Zhao, Y. (2023) Sino-European Economic and Trade Cooperation: Finding Certainty Amidst Uncertainty, China Social Sciences Network [【世局2023】赵永升：“经济共生”的中欧经贸——从“不确定性”中找“确定性]. https://www.cssn.cn/gjgc/gjgc_gcld/202301/t20230110_5578821.shtml.

40 Éltető, A., Peragovics, T., Sass, M. and Szunomár, Á. (2024) China's European Bridgehead?: The Chinese Economic Presence in Hungary. Friedrich-Ebert-Stiftung, Budapest. The term »bridgehead« (桥头堡) is used in Chinese government state planning, regional development and geopolitical-economic discourse. See, for example, Yinchuan Municipal People's Government (2025) Yinchuan Comprehensive Bonded Zone is building a »bridgehead« for an open economy and accelerating its progress towards a new high ground of high-level opening up [银川综保区打造开放型经济“桥头堡” 加速迈向高水平开放新高地]. https://www.yinchuan.gov.cn/xwzx/mrdt/202502/t20250225_4835797.html It is also used to describe the functional nodes that enable the China–Europe transcontinental economic corridor to operate and expand. See, for example, Suzhou Municipal Committee United Front Work Department (2016) Riding the new Silk Road on rails to reach the world, Suzhou private enterprises are seizing the »bridgehead«, with their Polish factories producing over 5 million monitors and flat-screen TVs annually, which are sold to various European countries [乘着铁轨上的新丝路奔向世界 苏州民企抢占“桥头堡”，波兰工厂年产500多万台显示器和平板电视销往欧洲各国]. https://tzb.suzhou.gov.cn/tzb/myjj/201606/8521607f90104614b5c6210cab4cd065.shtml. Especially in Chinese industrial analysis of EVs and batteries, Hungary is increasingly framed as a European »bridgehead«. See: Wu, Q. M. (2024) The embrace and resistance of Chinese battery investments in Hungary: The case of CATL, Asia Europe Journal, 22(2): 201–223. https://doi.org/10.1007/s10308-024-00699-9

41 State Information Center (2024) [Expert Opinion] Research on Pathways to Accelerate the Globalization of my country's New Energy Vehicle Industry [【专家观点】加快推动我国新能源汽车全球化发展的路径研究]. National Development and Reform Commission. https://www.ndrc.gov.cn/wsdwhfz/202408/t20240823_1392548.html In the case of BYD see https://cmr.berkeley.edu/assets/documents/pdf/2024-03-how-chinese-companies-are-dominating-electric-vehicle-market-worldwide.pdf

42 Gomes, A.P., Pauls, R. and ten Brink, T. (2023) Industrial policy and the creation of the electric vehicles market in China: demand structure, sectoral complementarities, and policy coordination, Cambridge Journal of Economics 47(1): 45–66. https://doi.org/10.1093/cje/beac056.

43 https://www.iea.org/reports/energy-technology-perspectives-2024. See also Whitfield, L. and Wuttke, T. (2026) China's technological catch-up and leapfrogging in electric vehicles: a firm-level study of BYD and CATL, Progress in Economic Geography 4(1). https://doi.org/10.1016/j.peg.2025.100054. Williams, G. (2026) Why Are Chinese EVs So Cheap? Note, 19 February, Rhodium Group. https://rhg.com/research/why-are-chinese-evs-so-cheap/

44 Humphrey, J. and Memedovic, O. (2003) The global automotive industry value chain: what prospects for upgrading by developing countries, UNIDO, Vienna.

45 See the case of CATL: Wu, Q.M. (2024) The embrace and resistance of Chinese battery investments in Hungary: The case of CATL, Asia Europe Journal 22(2): 201–223. https://doi.org/10.1007/s10308-024-00699-9

46 Especially because battery production by European firms is negligible. The development of the European battery industry has been slow and bumpy. The fate of Northvolt is a case in point. It will take years for factories to produce at the same quality and efficiency level of their Asian competitors. European gigafactories utilise only around 20 per cent of their potential capacity. Todts, W. (2026) Can Europe go electric and remain sovereign? T&E, 28 January. https://www.transportenvironment.org/articles/can-europe-go-electric-and-remain-sovereign

47 Interview with representatives of Eve Power.

48 The plant being built in Hungary is critical for the VW Group to obtain locally manufactured batteries for its European-made cars. This shortens the logistics chain between VW and Sunwoda. https://en.sunwoda.com/article/1330/9.html .

49 https://group.mercedes-benz.com/company/production/procuction-network/catl-partnership.html

50 CATL and BMW Sign an MOU to Deepen Cooperation on Battery Passport and Decarbonization. https://www.catl.com/en/news/6754.html

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