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The Interplay Between Firm Strategies and Government Industrial Policies

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Lindsay Whitfield, Felix Maile and Tobias Wuttke

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ABSTRACT

The transition from internal combustion engines to electric vehicles is fundamentally reshaping innovation and value capture across the global automotive industry, with European automakers and suppliers falling behind East Asian competitors dominating battery chemistry innovation, cell manufacturing, and process innovation in precision manufacturing. This report examines the emerging European battery supply chain based on interviews with East Asian and European battery firms, policymakers, and industry experts. We find that a battery supply chain is taking shape in Europe, but it is overwhelmingly dominated by East Asian firms investing in Central Eastern Europe. South Korean cell makers pioneered European production in the mid-2010s, producing in Poland and Hungary to supply German premium automakers, drawn in by generous government incentives in these two countries. Since 2023, Chinese battery firms and their material suppliers have also been expanding into Europe, pushed by price wars eroding margins in the Chinese domestic market and pulled by European carmakers' reliance on Chinese batteries. Hungary is emerging as a key hub for Chinese investment, alongside major investments by Chinese firms in Spain. In parallel, a Northern and Western European battery supply chain, driven by European battery startups and supported by government industrial policies and began to take shape in the late 2010s, but has not yet materialized. Many of the announced investments by European startups in Northern and Western Europe were recently downscaled or cancelled, and some European battery startups went bankrupt. Thus far, no European-owned battery producer has yet caught up on knowledge and manufacturing capabilities with the East Asian battery producers and achieved competitive production yields at scale.

Keywords: European automotive industry; battery production; industrial policy; firm-level capabilities; foreign direct investment

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1. Introduction

The transition from internal combustion engines to electric vehicles is fundamentally reshaping innovation and value capture across the global automotive industry. In this emerging landscape, European automakers and suppliers are falling behind East Asian competitors, particularly in battery cell manufacturing, which accounts for up to 50 percent of an EV's value. We use IEA's definition of electric vehicles (EVs), which includes battery electric vehicles, plug-in hybrid electric vehicles, fuel cell electric vehicles, and range-extended electric vehicles.

Innovation in battery manufacturing, and thus high value capture, occurs in four segments in the EV supply chain: (1) Battery materials, where scientific advances in cathode and anode materials drive improvements in performance, safety, and durability; (2) Battery cell design, where new battery chemistries are commercialized and different cell architectures enable different battery pack designs; (3) Battery pack design, where innovations in pack design improve car performance; and (4) Precision manufacturing in battery factories, where incremental process innovations reduce production costs and improve the quality of products. European carmakers have maintained battery pack design but lose value in EVs to firms that operate in battery cell manufacturing and battery materials production. Chinese battery producers are leading innovation and shaping the industry standards across cell architecture, chemistries and manufacturing processes.

This paper examines the emerging European battery supply chain based on interviews with companies, policymakers, and industry experts. We interviewed one European EV OEM, one Chinese EV OEM, six European-owned battery cell firms, one South Korean battery cell firm, four Chinese battery cell firms, and three battery material firms. We also interviewed representatives from the European Automotive Manufacturers' Association, InnoEnergy, the Hungarian Battery Association, and the Hungarian Investment Promotion Agency. The interviews were conducted in Hungary in autumn 2025 as well as online between October 2025 and July 2026.

The paper shows that a battery supply chain is taking shape in Europe, but it is overwhelmingly dominated by East Asian firms. Europe's EV battery industry began to develop in the mid-2010s, when South Korean battery cell producers LG Energy Solution and Samsung SDI established production facilities in Poland and Hungary, respectively, after losing the Chinese domestic market to Chinese firms. Samsung SDI, LG, and later SK On primarily supplied German premium automakers with nickel manganese cobalt (NMC) batteries in factories across Europe. They chose Hungary and Poland because of the investment incentives that the governments offered, and their South Korean battery material suppliers followed them. Since 2023, Chinese competition has put pressure on Korean firms in Europe to compete with Chinese firms' battery innovations. They have to invest in LFP chemistries, new cell designs, and next-generation chemistries. This dynamic shows the intensifying competition in the EV industry, which makes the challenges for Europe in catching up to the technological frontier even greater.

Chinese battery firms and their battery material suppliers are also investing in Europe as the result of push and pull dynamics. The push dynamic is intense competition in the Chinese domestic market, where price wars are eroding the profit margins of all firms, including BYD. Chinese battery producers see Europe as the next biggest EV market, especially since the US is not accessible due to high tariffs. Their aim is to capture market share by moving into Europe now, before European battery firms emerge or EU legislation locks them out. The pull dynamic is demand from European carmakers, which are under growing pressure from Chinese electric vehicle competitors and rely on Chinese batteries, given their proven capabilities in supplying at scale, cost and quality.

These push and pull dynamics brought Chinese battery producers to Europe, but they invested primarily in Hungary as a result of the government's proactive strategy to attract battery investments through generous incentive packages, with factories being established by CATL, EVE Energy, and Sunwoda. With CALB's factory in Portugal, Gotion's factory in Slovakia, and another CATL factory in Spain, all the major Chinese players are now in Europe, and their Chinese battery material supplier firms are following them.

The European Commission recognized the strategic risk of the hollowing out of its automotive industrial base after lobbying efforts by the European Battery Alliance in the mid-2010s. The Commission introduced policies to support European-owned battery cell producers, battery material producers, and research and development in next generation batteries. However, no European battery producers have emerged yet that can compete at scale with the Chinese firms. While Northvolt went bankrupt, ACC, Verkor, and PowerCo have not achieved competitive yields in their gigafactories.

The next section provides an overview of current and forecasted global and European demand for EVs and EV batteries. Section three discusses the global competitiveness of European firms in EVs and EV batteries, while section four explains the technologies and locus of innovation, and thus value capture, in the EV battery supply chain. The core of the paper is sections five, six and seven, which present the empirical findings on the emerging European EV battery supply chain, the role of EU industrial policies, and the role of firm strategies and national industrial policies in the Czech Republic, Poland, Hungary and

Slovakia, respectively. In concluding, we reflect on the changing geography of the automotive industry in Europe with the transition to EVs and its likely implications.

2. Global electric vehicle and battery demand and production: current trends and forecasts

The share of EVs increased from only 4 percent of global vehicle sales in 2020 to 18 percent by 2024, with sales in China accounting for 65 percent of global EV sales.[1] Chinese EV production represented 72 percent of global output in 2024, which exceeded domestic consumption by 1.1 million units and was exported to Europe and the rest of the world, as shown in Table 1.[2] Capacity utilisation rates of EV assembly factories were relatively uniform across regions, with China and Europe roughly equal. The International Energy Agency estimates EV sales of 40 million units by 2030, which exceeds current global EV production capacity by 37 percent (IEA 2023).[3]

Table 1. Electric vehicles demand, production and capacity (in 1,000 units), 2024

EVs	World	China	Europe	ROW
Demand	17,500	11,300 (65 %)	3,180 (18 %)	3,020 (17 %)
Production	17,300	12,400 (72 %)	2,500 (14 %)	2,400 (14 %)
Capacity	29,100	21,500 (74 %)	4,100 (14 %)	3,500 (12 %)
Capacity Utilisation	59 %	58 %	61 %	69 %

Source: Demand data is 2024 sales data based on IEA Global EV Outlook 2025, Global EV Data Explorer. Production and capacity data is 2024 data based on IEA World Energy Outlook 2025, p. 75.

Table 2. EV battery cells demand, production and capacity (in GWh), 2024

EV battery cells	World	China	Europe	ROW
Demand	996	566 (57 %)	170 (17 %)	260 (26 %)
Production	1,100	891 (81 %)	73 (7 %)	136 (12 %)
Capacity	3,364	2,827 (84 %)	173 (5 %)	364 (11 %)
Capacity Utilisation	33 %	31.5 %	42 %	37 %

Source: Demand data is for all sorts of e-vehicles, including passenger cars, buses, trucks, and two/three wheelers. Demand data is 2024 sales data based on IEA Global EV Outlook 2025, Global EV Data Explorer. Production and capacity data is 2024 data based on IEA World Energy Outlook 2025, p. 75.

[1] Global EV Outlook 2025 – Analysis - IEA. https://www.iea.org/reports/global-ev-outlook-2025.
[2] For production/capacity, the data is only available for Europe, not for EU27. Europe is defined in the IEA as the European Union regional grouping and Albania, Belarus, Bosnia and Herzegovina, Gibraltar, Iceland, Israel, Kosovo, Montenegro, North Macedonia, Norway, Republic of Moldova, Serbia, Switzerland, Türkiye, Ukraine and United Kingdom.
[3] Global EV Outlook 2023 – Analysis - IEA. https://www.iea.org/reports/world-energy-outlook-2023.

The battery pack constitutes 30 to 50 percent of an EV's value, and the battery cells account for approximately 70 percent of the battery pack's value.[4] China's share in global EV battery cell demand is 60 percent, aligned with its EV demand share (Table 2). However, its production share is much higher at 81 percent, while Europe and the rest of world have production shares lower than their demand, which means they import EV battery cells. As a result, China had a USD 58.7 billion lithium-ion battery trade surplus in 2024, while the EU had a trade deficit of USD 18 billion.[5] The overall gap between production and demand in Table 2 appears because demand data only includes demand for battery cells for EVs, but production plants can serve varying end markets, including energy storage, drones, robots and consumer electronics. However, EVs are by far the largest end market, at more than 85 percent, and this ratio is forecast to remain stable (IEA 2025, p. 134).

Table 2 shows very low average global battery cell factory capacity utilisation in 2024. One major reason is slower EV demand growth than assumed. In 2022, battery cell demand was projected to reach 1,700 GWh by 2025 (Fleischmann et al. 2023). However, actual demand in 2024 was less than 1,000 GWh. Another reason is that battery cell manufacturers cannot easily switch between different form factors (prismatic, pouch, cylindrical), creating demand-capacity mismatches when carmakers change their preferred cell designs for new vehicle models.

Low-capacity utilisation is not necessarily problematic for battery cell producers. Our interviews with battery cell manufacturers and other industry experts indicated that battery firms only build gigafactories based on off-take agreements with car producers per vehicle model. Some battery cell producers, especially startups, may build mega-factories (up to 1 GWh) without an off-taker agreement, but not factories of several GWh or larger. The off-take agreements contain take-or-pay commitments where cell producers fine carmakers for taking fewer cells than contractually agreed. Such fines occurred frequently in 2024 and 2025 due to slower EV sales than anticipated when agreements were signed.

Capacity utilisation rates are expected to increase as EV demand rises, but the difference between capacity and demand is still significant. Current forecasts anticipate 3,200 GWh EV battery cell demand by 2030, which means that current global installed capacity as of 2024 already exceeds the total anticipated 2030 demand.[6] Furthermore, the difference between capacity and demand is striking in China despite rapid recent EV uptake.

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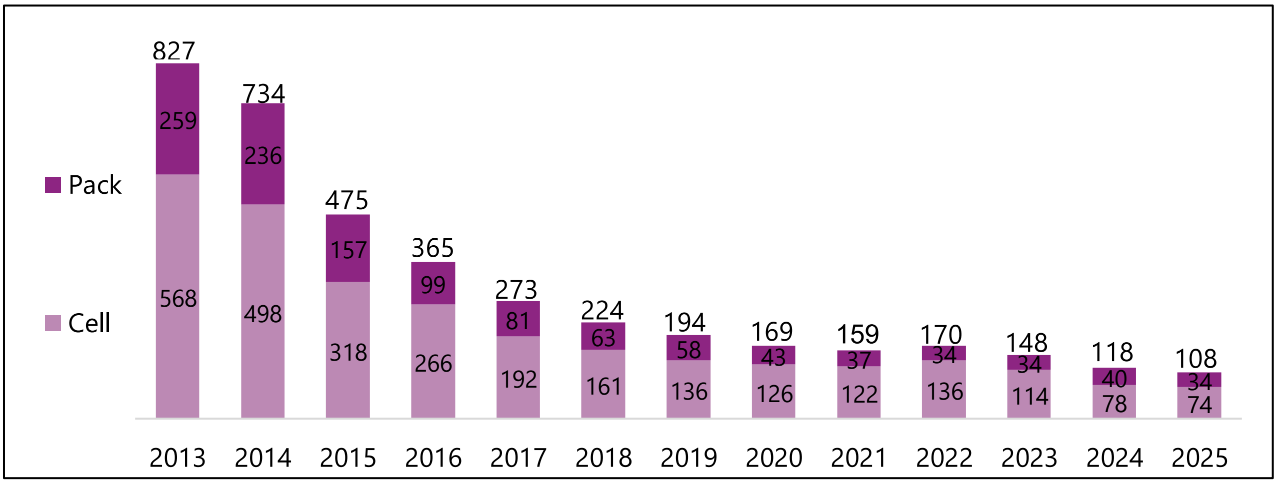
[4] Based on battery cell and pack price data from BloombergNEF between 2013 and 2025.
[5] Source: UN Comtrade data, HS 850760.
[6] The source for the 2030 demand forecast is IEA Global EV Outlook 2025, p. 136.

Globally, battery cell and pack prices declined significantly between 2013 and 2025, as shown in Figure 1, driven by price movements in China. The gradual drop in prices between 2013 to 2020 indicates the learning curve within Chinese battery cell producers, which pursued technological innovations in battery production and battery pack design (Whitfield and Wuttke 2026). Furthermore, the end of EV consumer subsidies by the Chinese government in 2022 resulted in EV producers in China absorbing the lower retail price through declining battery prices, which was possible due to high competition among battery cell producers and overcapacity (Luethje et al. 2022). This trend in turn incentivized the shift to lower-cost lithium iron phosphate (LFP) battery cells.

Figure 1. Battery pack and cell prices, real 2025 USD/kWh



Source: Weighted average survey data from BloombergNEF: https://about.bnef.com/insights/clean-transport/new-record-lows-for-battery-prices/.

3. Europe's global competitiveness in EVs and EV batteries

The European Union's largest manufacturing sector is the automobile industry, providing direct and indirect jobs for 13.8 million people, accounting for 6.1 percent of employment, and generating revenue equal to 7 percent of EU GDP.[7] In 2024, the EU produced 11.4 million cars, of all propulsion types, of which 7.2 million vehicles were sold within the EU. The EU had a trade surplus, exporting 4.5 million cars while importing 3.4 million units.[8] Battery electric vehicles accounted for 13 percent of the EU's car production and plug-in hybrids accounted for 6 percent, and the EU also had a trade surplus in electric cars.[9] Europe produced more EVs than North America and all of Asia combined excluding China. Approximately 75 percent

[7] European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs.
[8] The Automobile Industry Pocket Guide 2025/2026 - ACEA - European Automobile Manufacturers' Association. https://www.acea.auto/publication/the-automobile-industry-pocket-guide-2025-2026/.
[9] European Commission. Commission staff working document on significant distortions in the economy of the People's Republic of China for the purposes of trade defence investigations. https://data.consilium.europa.eu/doc/document/ST-8819-2024-INIT/en/pdf.

of European EV production occurred in Germany, making it the world's second-largest EV producer after China.[10] However, the EU faced a strong surge in imports in 2024, and imported EVs mostly from China (EUR 9.9 bn or 38 percent of EV imports), South Korea (EUR 3.1 bn), Japan (EUR 2.8 bn), and the US (EUR 2.7 bn) in 2024.[11]

In late 2024, the EU imposed countervailing duties on imported battery EVs from China based on an investigation which had concluded that the battery EV value chain in China benefited from 'unfair' government subsidies that caused a 'threat of economic injury' to European battery EV producers.[12] The tariffs reduced EU imports of battery EVs from China, but hybrids and plug-in hybrids from China increased, as did battery EVs from Korea and Japan.[13] The European countervailing duties on Chinese battery EVs, combined with benefits to local production for local sales (such as high transport costs for bulky components, just-in-time and just-in-sequence requirements, existing ecosystem strength), make domestic EV production likely to continue roughly tracking European sales. However, outcomes depend on European production competitiveness and EU policymaker reactions to changing circumstances.

The EV battery cell production and import situation in Europe is more concerning. Europe's current production only meets 43 percent of its demand, as shown in Table 2, with the remainder mainly met by Chinese imports. The largest operational EV battery cell plants in Europe as of 2026 are owned by South Korean firms, which at the invitation of European carmakers and politicians in 2015 built factories in Poland and Hungary (Li and Gong 2025). Other battery cell gigafactories currently being built are owned by Chinese firms (see Table 4 in section 4). European start-ups in battery cell production have yet to become operational at the gigafactory scale, with many projects cancelled or downscaled.

Current battery cell demand of EV producers in Europe is met to a significant extent by imported battery cells, predominantly from China. One major reason is that operational European factories all focused on nickel-based battery chemistries, for which demand has declined compared to lithium-iron-phosphate (LFP) batteries (see section 4). LFP battery cells were imported from China as Europe lacked production capacity, although several LFP factories are currently being built by Chinese firms (see section 5). European carmakers

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[10] German EV production data based on EV plant locations provided by ACEA and author's own web research on plant production data.
[11] Eurostat data.
[12] On the investigation, see Commission staff working document on significant distortions in the economy of the People's Republic of China for the purpose of trade defence investigations. Accessed at: https://ec.europa.eu/transparency/documents-register/detail?ref=SWD(2024)91&lang=en. On the countervailing duties, see https://trade.ec.europa.eu/access-to-markets/en/news/eu-commission-imposes-countervailing-duties-imports-battery-electric-vehicles-bevs-china.
[13] Eurostat data.

would source from China if all factors considered (price, supply speed, etc.) made imported Chinese cells preferable to locally produced cells. Our interviews suggest that the localization of the battery supply chain in Europe is primarily politically driven, reflecting both European policymakers' strategic concerns and Chinese battery firms' responses to current and anticipated EU policies shaped by these concerns (see section 6). Chinese companies know that there will be counterreactions by European politicians if the supply chain remains in China. In addition, Chinese firms face a slowing market, high competition for market share and falling prices in China and thus see the European market as an opportunity (Gong et al. 2026).

European EV producers like Volkswagen, BMW, and Renault are globally competitive in EV production, even though they are not global leaders (as they were in internal combustion engine-based vehicles). However, European battery cell producers are not globally competitive. Their global market share is less than 1 percent. EV battery cell production is globally dominated by Chinese firms (CATL, 37.9 %; BYD, 17.2 %; CALB, 4.4 %; Gotion, 3.2 %; EVE, 2.3 %; Sunwoda, 2.1 %), South Korean firms (LG ES, 10.8 %; SK On, 4.4 %; Samsung SDI, 3.3 %) and one Japanese firm (Panasonic, 3.9 %).[14] Supply of battery cell components, including cathode and anode active material, electrolytes and separators is also dominated by Chinese and South Korean firms, alongside a small number of Japanese firms.

Chinese firms are global leaders in the production of EVs, battery cells, battery cell components, and battery cell materials. Their leading position is not wholly the result of state subsidies, but rather China's extensive LIB production and innovation ecosystem that has emerged over three decades. The Chinese EV battery firms are 10 to 20 years ahead on the learning curve compared to European start-ups, facilitated by China's large domestic EV market. This domestic market, in turn, was the result of specific government policies that pursued technological leadership in alternatives to the internal combustion engine cars to circumvent the incumbency advantages of existing European, American, Japanese, and Korean players (Whitfield and Wuttke 2025). Government policies included consumer purchase subsidies for 'new energy vehicles', covering 40 to 60 percent of EV costs, which were piloted in 2009, and extended in 2010 and 2013 to cover more cities (Whitfield and Wuttke 2026). Only after this expansion did EV sales grow considerably, but purchase subsidies decreased gradually, fully ending in 2022. EV and EV battery producers benefited from supply-side benefits such as cheap credit and land access, tax exemptions, and various other difficult-to-quantify benefits. Another benefit was the dual-credit policy of the government, introduced in 2017, which stipulated that Chinese carmakers meet targets for the share of new energy vehicle production in their total production volumes. This policy was an indirect supply-side subsidy because overperforming carmakers accumulated credits that

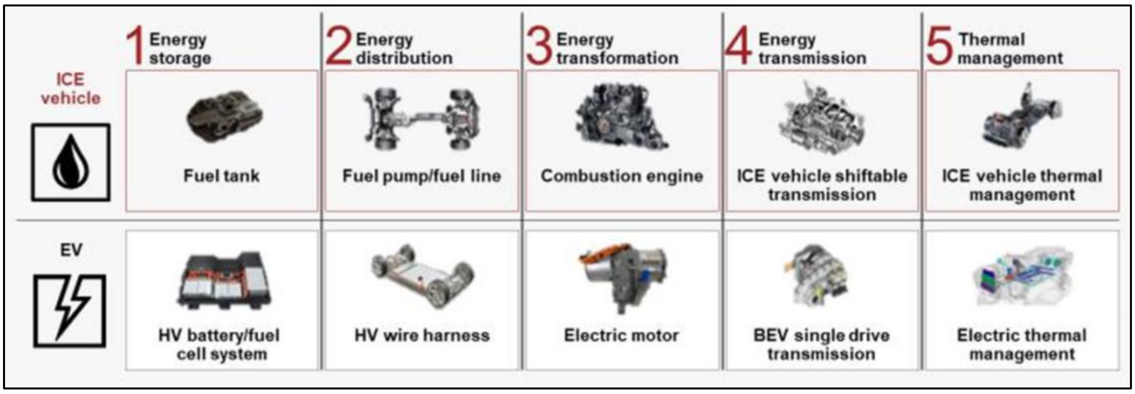
[14] Global market share data from SNE Research for 2024.

they sold to underperformers, providing an important source of income for some Chinese EV producers.

EV battery firms benefited from government purchase subsidies for new energy vehicles, expanding EV demand and, in turn, battery demand beyond what would have occurred without incentives. As components of the new energy vehicles sector, batteries also benefited from various supply-side support measures. However, the most important policy was arguably the Automotive Power Battery Industry Specification, commonly known as the Battery Whitelist. This policy stipulated that between 2016 and 2019, only new energy vehicles equipped with batteries manufactured by Chinese firms were eligible for purchase subsidies (Gong and Hansen 2023). Similar local content requirements were also in place for electric motors and inverters. The requirements were always temporary to avoid local firm complacency. The large market demand for EVs in China and associated economies of scale created opportunities for Chinese EV battery firms to learn, build capabilities, and eventually leapfrog into global technological leadership (Whitfield and Wuttke 2026). Thus, Chinese EV battery firms are highly competitive, cutting-edge technology firms that benefited from systematic state support over a decade while undertaking significant efforts to build knowledge and capabilities, innovate, and leverage China's extensive three-decade lithium-ion battery production and innovation ecosystem, which started to produce batteries for consumer electronics in the 1990s.

The implications for Europe are two-fold. There is the risk of hollowing out the European automotive manufacturing chain during the shift from internal combustion engine cars to electric vehicles, if firms producing components for internal combustion engines disappear without replacement by firms producing the new components, which are shown in Figure 2. This would happen if battery cells, which constitute 30 to 50 percent of the value of EVs, are imported from China instead of being manufactured in Europe. This risk can be mitigated in the short term by attracting Asian battery cell producers to set up factories within Europe, which the governments in Poland and Hungary did (see section 6). However, it introduces the second risk – that the currently uncompetitive European battery firms, which have just begun their learning curve, will not be able to compete with the Asian firms and die out, leaving the EV battery supply chain dominated by foreign firms. The policy challenge is then one of supporting European firms in technological catch-up. The European Battery Alliance was formed to support this objective, driven by a northern European alliance, and it influenced the European Commission to adopt policy measures to support European battery startups. However, European battery startups are still struggling, and EU policy measures have not been very effective, as discussed in section 6.

Figure 2. Internal combustion engine and electric vehicles key components compared

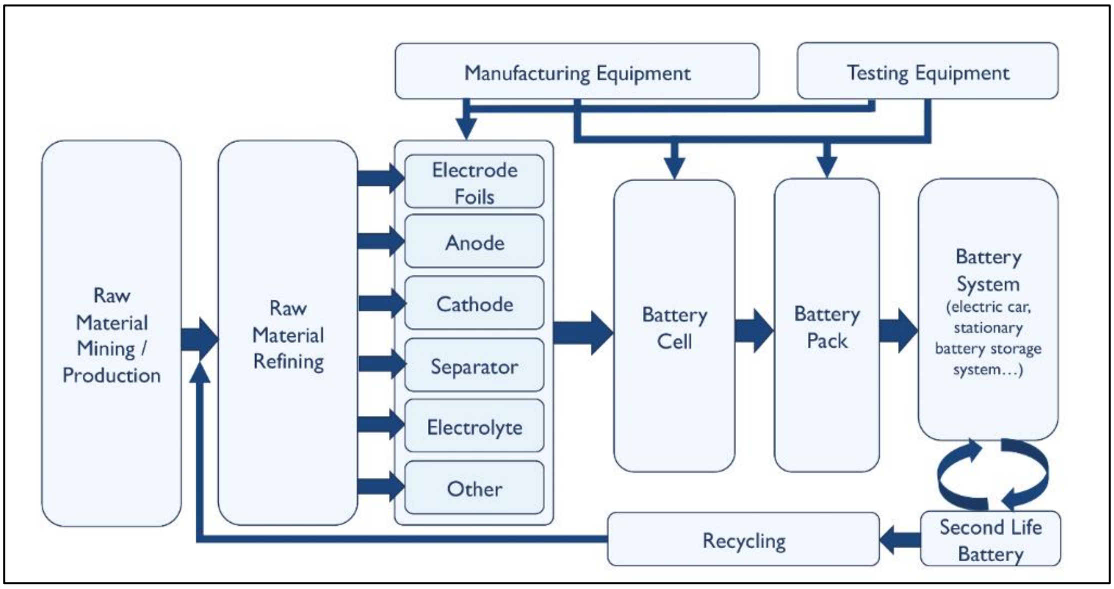


Source: European Association of Automotive Suppliers (CLEPA). (https://www.clepa.eu/wp-content/uploads/2021/12/Electric-Vehicle-Transition-Impact-Report-2020-2040.pdf

4. Technologies and value capture in the EV battery supply chain

The EV battery manufacturing supply chain has several steps that are generally carried out by separate firms, although there are varying degrees of vertical integration among Chinese firms. For the purposes of understanding the manufacturing steps, the paper briefly goes through these steps, which are depicted in Figure 3. These steps indicate what is necessary to have a complete battery supply chain in Europe. After describing the basic steps, we will discuss different types of battery cell designs (called form factors) and battery cell chemistries, which have important implications for how battery packs are designed. In the final part of this section, we discuss where innovation occurs, where proprietary knowledge is produced, and thus where value capture is highest but also where competition occurs.

Figure 3. The EV battery supply chain



Source: Yole Group Consulting Services. Retrieved from https://www.knowmade.com/technology-news/energy-technology-news/batteries-news/e-mobility-new-eldorado-li-ion-batteries/.

The battery cell consists of four major parts: a *cathode* and an *anode* separated physically from the cathode by a *separator*, with an *electrolyte* providing ionic conduction between them (Coffin and Horowitz 2018). During discharge, lithium ions move from the anode to the cathode through the electrolyte. The discussion here focuses on lithium-ion batteries. The battery science will differ for solid state or sodium-ion batteries. For lithium-ion batteries, the separator is a porous plastic film through which the liquid electrolyte permeates, so it is the least complex part. The electrolyte typically consists of organic carbonate solvents with dissolved lithium salts. The anode is typically made of graphite, but there are some current innovations with silicon. The cathode is the most expensive component in battery production, and it can have different chemical compositions, such as lithium-nickel-cobalt-aluminum oxide (NCA), lithium-manganese oxide (LMO), lithium-nickel-manganese-cobalt-oxide (NMC) and lithium-iron-phosphate (LFP). LMO was used in the Nissan Leaf, one of the first EV models, but is not popular anymore. Telsa initially used NCA. Many premium car models in the West used NMC. LFP was introduced by Chinese firms. The point is that battery chemistry has changed, and continues to change, as firms innovate with battery chemistries to achieve better cost-performance ratios. Thus, battery chemistries will continue to change in the future through innovations, as firms seek competitive advantages.

For example, LFP is safer than nickel-based, is cheaper (based on the cost of minerals), and can survive more recharging cycles. However, nickel-based batteries have a higher energy density and thus less weight of the battery for the same performance (driving range). For these reasons, NMC tends to be used in premium vehicle models, because it is costlier but has a higher energy density, and LFP in non-premium vehicle models. However, as BYD and CATL innovated with battery pack design, the performance gap closed, giving LFP a market advantage because it achieved the performance of NMC battery packs but with a lower price tag.

As noted, the battery chemistry for cathodes and anodes matters for which raw materials are required to make the battery. EVs use about six times more rare minerals than internal combustion cars because of the battery.[15] While mineral deposits are found around the world, Chinese firms invested in many of them, leading China to control 41 percent of the world's cobalt, 28 percent of lithium, and 78 percent of graphite, but only 6 percent of nickel and 5 percent of manganese. However, the picture in mineral refining looks quite different, with China refining 95 percent of manganese, 73 percent of cobalt, 70 percent of graphite, 67 percent of lithium, and 63 percent of nickel. This refining capacity emerged because China became the world's factory for electronics, which required lithium-ion batteries (Greitemeier

[15] Can the world make an electric car battery without China?, A. Chang and K. Bradsher, 16 May 2023, The New York Times.

et al. 2025). Also as a result, China makes most of the parts that go in a battery: 77 percent of cathodes, 92 percent of anodes, 74 percent of separators and 82 percent of electrolytes.[16] The large market for battery materials in China led to falling prices for anode and cathode materials, due to improved production methods and scaled-up manufacturing by Chinese battery material firms.[17] Its long history of battery production also means that China has many firms that produce the equipment required for battery component and battery cell manufacturing.

There are different battery cell form types, in which the battery cell parts are contained: cylindrical, pouch, and prismatic. Cylindrical was the form type used in consumer electronics, and Tesla was the first EV producer to use cylindrical cells which were produced by the Japanese firm Panasonic. Cylindrical cells have high energy densities and were easy to scale for mass production due to established manufacturing processes. Developments for prismatic and pouch cell types resulted from changing the cell structure to fit with passenger cars.[18] The pouch type cell can also provide high energy densities due to the low weight of the cell housing, high flexibility in manufacturing, but its low mechanical stability (it expands when the ions flow) puts high constructional demands in module design. Prismatic cells are easy to integrate in modules and direct integration (cell-to-pack), but they have lower energy density than the other two types, due to the volume utilization in the cell and the weight of the cell housing.[19] Thus, each cell form type has advantages and disadvantages, and thus the battery literature indicates that there is no clear winner among the different types.

Competition centres around the battery pack design, where innovation takes place in how the battery cells are put together and in the thermal management system. Variations in the battery pack design determine the overall performance of the battery pack, including achieving higher useable energy densities.[20] CATL and BYD pioneered elongated prismatic LFP cells for direct integration into the pack, omitting modules to improve utilization in the overall pack space for higher energy density and reducing manufacturing costs (Gorsch et al. 2025).[21] BYD produced the first generation of its 'blade' (long) prismatic cell in 2020, and a second generation in 2026. CATL produces a prismatic cell type with the same advantages of BYD's blade. Cell-to-pack required innovations in the pack design to limit undesirable electrical and thermal conditions. As a result, their LFP battery packs could compete with the

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[16] Can the world make an electric car battery without China?, A. Chang and K. Bradsher, 16 May 2023, The New York Times.
[17] Competitive market for battery materials: Market leaders, technologies and cost analysis, G. Sirma and T. Wicke, 13 March 2025, Fraunhofer Battery Update.
[18] Development perspectives for lithium-ion battery cell formats, November 2022, Fraunhofer.
[19] Development perspectives for lithium-ion battery cell formats, November 2022, Fraunhofer.
[20] Ibid.
[21] Contrasting a BYD Blade prismatic cell and Tesla 4680 cylindrical cell with a teardown analysis of design and performance. Gorsch et al., 2025, Cell Reports Physical Science 6, 102453.

performance of NMC battery packs on performance and be offered at a lower price, causing a shift in the Chinese market from NMC to LFP and other Chinese firms trying to follow the trend of 'blade-like' LFP battery packs (see Whitfield and Wuttke 2026). Another area of innovation has been the tab design, which is important for improving charging efficiency, thermal safety and other performance parameters.

Thus, firms pursue innovations not only in the battery cell design but also in the battery pack design, which means that there is a high level of value capture at the battery pack design stage. As a result, if EV producers buy the entire battery pack from battery cell producers, as many of the Chinese carmakers did, this makes it easy for conventional carmakers to make the switch to EVs, but their profit margins will be very thin. European carmakers know this and are therefore trying to keep battery pack design in-house or have strategic partnerships with battery cell producers, including equity investment.[22]

The shift in the Chinese market towards LFP batteries also influenced European carmakers and the European market towards LFP prismatic cells with cell-to-pack designs, or something that can compete with it. For example, Volkswagen's new 'unified cell' is also cell-to-pack.[23] Mercedes' MMA vehicle platform uses prismatic cells with a cell-to-pack 'lite' approach – four large cell compartments instead of many small modules.[24] The innovation continues in both the Chinese and European market. For example, the Chinese firm CALB is producing a U cell that is achieving similar cell-to-pack advantages.[25] These new form factors can be NMC or LFP, but there is also a strong trend towards LFP in Europe to bring down the cost of EVs. This has led many European carmakers to either implement or announce plans to introduce LFP batteries into their 'base' models, including Stellantis, Volkswagen and Renault.[26] Nevertheless, other form factors continue to exist. BMW's Neue Klasse model, for example, uses 46xx cylindrical cells.

The drive to compete by being the first firm to commercialize the next generation of battery technology has led to investments in solid-state and sodium-ion battery chemistries, both in China and Europe.[27] Solid-state batteries hold the potential for higher energy densities, doubling the capacity of today's lithium-ion batteries, which would enable EVs to achieve ranges of over 1,000 kilometres on a single charge. However, solid-state batteries remain

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[22] Interview, CATL Hungary office, 11 November 2025.
[23] https://ecomento.de/2025/05/15/neuer-meb-vw-setzt-auf-lfp-technologie/.
[24] Public interview with Head of Battery Strategy, Mercedes-Benz. Accessed via https://geladen.podigee.io/231-mercedes-elektroautos, 15 March 2026.
[25] https://batteryindustry.net/calb-unveils-u-shape-ev-battery-structure-for-higher-4680-or-lfp-cells-energy-density-and-10-minute-charging/.
[26] Iron and phosphate to unlock the mass-market EV at last, 16 January 2025, M. Takahashi, IDTechEX. www.idtechex.com/journal/.
[27] https://christopherchico.substack.com/p/solid-state-batteries-why-mass-production.

complex and costly to manufacture. The French firm Blue Solutions is currently mass-producing polymer-based solid-state batteries with factories of 1.5 GWh in France and Canada for electric buses and is working on its next generation battery for passenger cars.[28]

Sodium-ion batteries are likely to appear sooner than solid-state, which cannot yet be scaled profitably. Sodium-ion replaces the lithium with sodium chloride, which is much cheaper than lithium, but the challenge is to improve the energy density. CATL has launched the Naxtra sodium-ion battery, which achieved similar energy density as LFP and estimates that it can be competitive with LFP in the low range vehicle market (Machin and Marquez 2026). The Korean firm LG Energy Solutions is producing sodium-ion batteries in China because the supply chain is there: cathode suppliers, anode manufacturers, and equipment vendors required to make sodium-ion cells at commercial scale.[29] In response to the sharp rise in lithium prices during 2021 and 2022, both the Chinese government and domestic companies moved to diversify battery material supply chains away from lithium. Sodium-ion technology was identified as a strategic priority in the 14th Five-Year Plan, leading to the rapid development of a complete battery materials supply chain between 2022 and 2025.[30] Thus, we can expect that sodium-ion batteries will be scaled in China first.

Battery cell manufacturing factory setup depends heavily on the cell form type as it requires specialized equipment and machinery.[31] The assembly equipment generally is adapted to one specific cell size. Battery production starts with the processing of the electrode coils: aluminum (cathode) or copper (anode) foil coated with active battery materials, dried, and compacted. The anode and cathode materials are stacked, winded, folded and joined with the separator. Several contacting and handling steps follow, the electrolyte is filled in, and the assembly ends with a sealing process. All the processes up to sealing must happen in a dry and clean environment. In the many handling processes, the grippers and tools are specific to each cell dimension. Thus, a change in cell format requires new tools and even equipment, and a change in cell size requires changing processes. There are also differences in the manufacturing processes between traditional prismatic cell types and blade prismatic.

Due to the complex nature of battery manufacturing, firms engage in continuous improvements and innovations. Unlike semiconductor manufacturing where the design can be simulated, battery manufacturing is more of an art, driven by iterative trial and error.[32] For example, LFP cells pioneered by Chinese firms use different electrode designs, mixing

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[28] https://source.benchmarkminerals.com/article/solid-state-production-forecast-to-hit-2-gwh-this-year-as-oxide-batteries-dominate.
[29] https://battery-news.de/en/2026/01/22/lg-energy-solution-prepares-pilot-production-of-sodium-batteries/.
[30] https://christopherchico.substack.com/p/sodium-ion-creates-another-china.
[31] Development perspectives for lithium-ion battery cell formats, November 2022, Fraunhofer.
[32] Interview with the Managing Director of a battery materials company.

ratios and process windows than the high-nickel chemistries that Korean firms perfected. An industry expert estimated that typical learning curves run three to five years from pilot production line to stable yields and then two to three more years for cost optimization in the manufacturing process at scale.[33] Thus, it takes several years for a factory to change from one cell form type and chemistry to another, not just to retool the factory but also to gain the tacit knowledge and to build the supply chain relationships necessary to achieve cost competitiveness with established firms in that form factor and chemistry.

5. The European EV and EV battery supply chain

This section explains the emergence of a European EV and battery supply chain, covering major investments in battery cell manufacturing, including form factors, chemistries, and the OEMs supplied by each cell maker. It also examines the emerging supply chains for battery active materials (anodes and cathodes) and components (electrolytes and separators), highlighting the regional clusters that are developing. Section 6 discusses EU policy drivers, while Section 6 covers national government policies in Eastern Europe that have influenced the location of battery supply chain firms.

The share of battery EVs in total passenger car sales in Europe increased from 5.3 percent in 2020 to 14.3 percent in 2023, but then fell to 13.3 percent in 2024, before rebounding in 2025 to 15.9 percent.[34] New car registrations in 2025 by power source showed that 17.4 percent were battery EVs and 9.4 percent were PHEVs, which was an increase from 2024.[35] Data on passenger car sales in Europe for 2024 disaggregated by carmaker (Table 3) shows the extent to which European carmakers are producing EVs as a percentage of their total production. Tesla produces only BEVs. Among the rest, Volvo, BMW and Mercedes-Benz have higher shares of EVs in their total production than the other carmakers. Volvo, BMW, and Mercedes operate in the premium segment, where the higher price of battery EVs has been less of an obstacle for consumers, which partly explains their high EV share in total sales. Volvo has been the most ambitious carmaker with regards to EVs and has been a forceful proponent of stricter EU emissions regulations, reflecting their ambitious electrification strategy (Fischer 2025). Notably, Volvo Cars is owned by Chinese carmaker Geely.

[33] Interview with the European representative of NICE LMS Europe and previous representative for Samsung SDI European branch.
[34] T&TE Progress Report 2025. Accessed at: https://www.transportenvironment.org/articles/ev-progress-report-2025.
[35] https://www.acea.auto/pc-registrations/new-car-registrations-1-8-in-2025-battery-electric-17-4-market-share/.

Table 3. EV shares in total passenger car sales in Europe by carmaker, 2024

Carmaker	BEV %	PHEV %
Tesla	100	0
Volvo-Polestar-Suzuki	27	19
BMW	22	14
Mercedes-Benz	18	21
Volkswagen Group	12	6
Hyundai	11	4
Kia	12	9
Stellantis	10	4
Renault-Nissan-Mitsubishi	8	1
Ford	7	9
Subaru-Mazda-Toyota	2	5

Source: Created by the authors. Data from https://theicct.org/publication/european-market-monitor-cars-vans-2024-feb25/

The operational battery cell production in Europe was primarily by Asian firms in 2026, as shown in Table 4. South Korean battery firms Samsung SDI, SK On and LG Energy Solutions have been producing the longest, starting in 2017. The Japanese firm ASEC was producing in the UK for Nissan on a small scale, and recently took a Chinese partner Envision, with the intention to expand the scale and most probably upgrade its battery technology. Several European startups emerged in the early 2020s, but only PowerCo, ACC and Verkor have established operational factories so far. Their capacities in Table 4 are likely to be significantly overstated, based on our interviews with industry experts. PowerCo is the battery subsidiary of VW, and Automotive Cells Company (ACC) was established as a joint venture among Stellantis, Mercedes-Benz and Saft (an established French company specializing in batteries that was developing lithium-ion batteries for EVs and then acquired by Total Energies in 2016). Verkor was founded by several French funds and firms, including Renault (20%). EIT InnoEnergy, a clean tech venture capital firm funded by European industrial and financial firms, backed several European startups with finance and succeeded in getting the European Investment Bank to provide financing as well.

Chinese EV battery producers began investing in Europe after the emergence of the European startups, with most factories still under construction. CATL was the first, with a small gigafactory factory in Germany operational since 2023, but other top Chinese batteries producers have followed (EVE, Sunwoda, Gotion, CALB) and their factories are expected to come online in 2027 and 2028. In addition, CATL is adding large gigafactories in Spain and Hungary. The factory in Hungary will start operations in 2026, but at the time of the research was only assembling modules with imported cells.

Table 4. Lithium-ion battery production in Europe, operational and planned, 2026

Country	City	Firm	Firm ownership	Start of production* & plant size	Form factor & chemistry	Customers**
Hungary	Göd	**Samsung SDI**	**South Korea**	**2017, 40 GWh**	**Prismatic NMC**	VW, BMW
	Komarom; Ivansca	**SK On**	**South Korea**	**2020, 17 GWh 2024, 30 GWh**	**Pouch NMC**	VW, Mercedes-Benz, Ford, Kia, Hyundai
	Debrecen	*CATL*	*China*	*2026, 40 GWh 2027, 80 GWh*	*Prismatic 80% NMC 20% LFP*	Mercedes-Benz, BMW, VW, Renault
	Debrecen	*EVE Energy*	*China*	*2027, 30 GWh*	*Cylindrical NMC*	BMW
	Nyíregyház a	*Sunwoda*	*China*	*2028, 17 GWh*	*Prismatic NMC & LFP*	Volvo
Poland	Wroclaw	**LG Energy Solution**	**South Korea**	**2017, 86 GWh**	**Pouch NMC**	BMW, VW Group, Fiat, Ford, Hyundai
Slovakia	Šurany	*Gotion Inobat Batteries*	*Gotion (China) 80% & Inobat (Slovakia)*	*2027, 20 GWh*	*Unified cell (prismatic)*	VW
Germany	Erfurt	**CATL**	**China**	**2023, 8 GWh** (aim is 14 GWh)	**Prismatic NMC**	BMW, VW, Volvo, Porsche, Mercedes-Benz
	Salzgitter	**PowerCo**	**Germany**	**2025, 20 GWh**	**Unified cell (prismatic) LFP & NMC**	VW
	Ellwangen	**V4Smart**	**Germany**	**2025, 0.4 GWh**	**Cylindrical NMC**	Porsche
	Grünheide	*Tesla*	*Germany*	*2027, 8 GWh*	*Cylindrical NMC & prismatic LFP*	Tesla
Spain	Figueruela s, Zaragoza	*CATL/ Stellantis*	*China-France-Italy-US*	*End of 2026, 50 GWh potentially*	*Prismatic LFP*	Stellantis
	Sagunt	*PowerCo*	*Germany*	*2027, 40 GWh*	*Prismatic LFP & NMC*	VW
	Cáceres	*AESC-Envision-*	*Japan 20%, China 80%*	*2026, 30 GWh*	*Prismatic LFP*	Nissan
	Vitoria-Gasteiz	*Basquevolt*	*Spain*	*2027, 10 GWh*	*Pouch Solid-state*	
Portugal	Sines	*CALB*	*China*	*2028, 15 GWh*	*Prismatic LFP*	Toyota, Ford, VW, Audi
France	Dunkirk	**Verkor**	**France**	**2026, 16 GWh**	**Cylindrical & pouch, NMC**	Renault

Country	City	Firm	Firm ownership	Start of production* & plant size	Form factor & chemistry	Customers**
	Douvrin	**ACC**	**France-Germany**	**2024, 13 GWh**	**Prismatic NMC**	Stellantis, Mercedes-Benz
	Douai	**AESC-Envision-**	**Japan 20%, China 80%**	**2025, 10 GWh** (up to 24 GWh)	**Pouch NMC**	Renault
	Dunkirk	*ProLogium*	*Taiwan*	*2028, 0.8 GWh 2032, 12 GWh*	Pouch Solid state	
UK	Sunderland	**AESC-Envision**	**Japan 20%, China 80%**	**2018, 1.9 GWh** *2030, 25 GWh*	**Pouch NMC**	Nissan (UK)
Serbia	Subotica	*ElevenEs*	*Serbian*	*2027, 1 GWh*	*Blade prismatic LFP*	

Notes: ***Battery firms in bold are operational. Firms in italics have factories that are under construction.
** We tried to verify the customers, but since cell producers rarely confirm their customers and OEMs rarely confirm their suppliers, there is some uncertainty on the accuracy of customers reported in this table.
Sources: Complied based on firm websites of battery cell manufacturers; interviews with firm managers (for Hungary plants); 'IPCEI Batteries. Market Updates Q2 2025' (https://www.ipcei-batteries.eu/fileadmin/Images/accompanying-research/market-updates/2025-06-BZF_Kurzinfo_Marktanalyse_Q2_ENG.pdf)

The Korean and European battery factories produce NMC batteries in different form factors, as NMC was demanded by European carmakers. As of March 2026, there are no operational LFP plants in Europe. However, European LFP production capacity will emerge through investments by Chinese firms. Our interviews with CATL confirmed that the new plant under construction in Spain will produce LFP, and that 20 percent of the capacity at the new plant in Hungary will be dedicated to LFP. Additionally, our discussion with InoBat confirmed that its joint venture with Gotion, Gotion-InoBat Batteries (GIB), will produce LFP battery cells in Slovakia. Media reports indicate that CALB's plant under construction in Portugal is expected to produce LFP; however, as we have not spoken with CALB directly, this cannot be confirmed. We will discuss the evolution of investments, looking first at the Korean investments, the European effort catalyzed by the European Battery Alliance, and the surge in Chinese investments.

Both demand forecasts as well as production capacity forecasts for EV battery cells are highly uncertain. However, if we look at the capacity investment announcements by established players like CATL, EVE, Samsung SDI, SK On, LG, Gotion, and CALB, which are more certain to materialize than those by the European start-ups, then battery production capacity in Europe will amount to roughly 380GWh. All this capacity should be operational by 2030. If the announced (and not yet cancelled) capacity of the largest European startups PowerCo, ACC, and Verkor (170GWh) as well as that of other Asian firms AESC-Envision and ProLogium (163GWh) is added with a probability value of 50 percent, Europe will have a battery cell production capacity of 720 GWh by 2030. This amount exceeds the EV battery cell demand in

Europe of 590 GWh that the IEA forecasts (IEA Global EV Outlook 2025, p. 136). There are a lot of variables in forecasting that require assumptions, but the most important is EV demand. Thus, without a significant increase in EV demand driven by government policies, current battery production investments will meet market demand, leaving little room for new investments unless they are driven by innovations in battery chemistry and form factor and thus replace existing demand.

The three major South Korean battery firms LG, Samsung, and SK all invested in Europe and in the US in between the mid-2010s and the early 2020s. In Europe, they invested in Poland and Hungary, in response to government subsidies, as discussed in section 6. Samsung SDI set up a factory in Hungary in 2017 to produce NMC prismatic battery cells for BMW. SK On (in Hungary, since 2020) and LG Energy Solutions (in Poland, since 2017) produce NMC pouch battery cells for a wider range of carmakers in Europe. The South Korean firms were early movers into production within Europe because they depended on the European market for a significant proportion of their sales. For example, in 2024, Europe accounted for 27 percent of the revenue stream of LG Energy Solutions and 34 percent of Samsung SDI, and the US accounted for 42 percent in both firms (Richter et al. 2026: 38).

In contrast, the Chinese battery firms produced mostly for the Chinese market. But European carmakers' turn to Chinese EV batteries increased competition for the Korean firms in the European market, taking market share from them, especially with the Chinese firms' innovation in LFP batteries that rival the performance of NMC batteries but at lower cost. Then, Chinese battery firms' investments since 2023 signalled a major move into the European market.

The European Battery Alliance, established in 2017, was the effort of European entrepreneurs and some European carmakers to create European startup battery cell manufacturers. As discussed in section 6, it was spearheaded by Northvolt and EIT InnoEnergy, and had support from VW, BMW and Renault, and was endorsed by the European Commission. It succeeded in getting 'EV battery' classified as a strategic sector where state aid could be used, including two Important Projects of European Common Interest. Northvolt was the flagship project, established by ex-executives at Tesla, which secured significant corporate and venture capital investment.

European policies and support are discussed in more detail in the next section, but the upshot is that European battery startups have not performed well so far. Northvolt went bankrupt, and several projects were cancelled. Furthermore, PowerCo, ACC and Verkor are yet to achieve competitive yields at the gigafactory scale of production, according to multiple interviews with industry experts familiar with the companies. These start-ups struggle to build proprietary capabilities in mass manufacturing on their own. ACC recently took a

Chinese partner on board. Furthermore, VW involved Gotion, in which it owns a 20 percent stake, in PowerCo's Germany plant.[36] Overall, our interviewees indicated that members of the European Battery Alliance initially underestimated both how difficult it was to produce batteries at scale as well as the competence and manufacturing lead of Asian firms.

The top Chinese battery firms are opening battery factories in Europe because of both push and pull effects. The academic literature documents that the Chinese market is characterized by high competition and market saturation (CEIAS 2025; Li and Gong 2025; Gong et al. 2026). Our interviews with Chinese battery firms confirmed this point and added that expansion requires going international, and the European Union is the next biggest market after China. Other interviewees commented that the emergence of European startups sped up the process, as Chinese firms wanted to invest in Europe and secure market share while there was not much competition.

The European EV market is shifting increasingly toward LFP batteries, which places significant pressure on South Korean battery producers. Prior to 2023, the South Korean battery firms had dominated the EU and US market. In Hungary, Samsung SDI had produced batteries for BMW, Rivian, and Audi, and SK On produced batteries for Hyundai, Mercedes-Benz, Ford, and Volkswagen. In Poland, LG Energy Solution supplied batteries to Tesla, Volkswagen, Chevrolet, and Ford.[37] As EV sales in Europe stalled in 2024 and cost gaps between EVs and internal combustion engine vehicles persisted, competition among European carmakers moved away from range differentiation toward cost-based competition.[38] European carmakers increased their sourcing from Chinese battery firms because Chinese firms had achieved major innovations in extending LFP range and cost-efficient production based on the widespread adoption of LFP chemistry as the dominant chemistry in the Chinese market (see Whitfield and Wuttke 2026). As a result of the slowing EV sales in Europe and the US and the shift toward cost-based competition, LG Energy Solution and Samsung SDI have faced operating losses because they depended much more on the US and EU market than their Chinese competitors (Richter et al. 2026)

The underlying key issue is the specialization of South Korean battery producers (LG Energy Solution, Samsung SDI, and SK On) on NMC and NCA chemistries. As a former executive of a South Korean battery firm noted, the South Korean battery firms disregarded LFP for a long time. They assumed that their focus on high-range NMC and NCA batteries, capable of delivering 500 to 700 km per charge, was what the market wanted. Despite the cost and safety advantages of LFP, they expected that Chinese firms would not be able to significantly

[36] Interview with executive at InnoEnergy.
[37] https://www.sneresearch.com/en/insight/release_view/545/page/0.
[38] https://www.iea.org/commentaries/global-battery-markets-are-growing-strongly-and-so-are-the-supply-risks.

improve the performance of LFP batteries beyond a 200 to 300 km range. As a response to the falling global market shares, Samsung, LG, and SK have started to invest heavily in developing LFP batteries, which entails different electrode designs and material compositions. It also requires developing new supply chains for LFP cathode materials, which are currently heavily concentrated in China.[39]

Given that all EV battery factories in Europe until recently produced NMC batteries, all operational firms producing cathode active materials produce NMC materials, except for a small factory producing LFP cathode material for PowerCo (Table 5). Before 2022, all cathode active material was imported by the Korean battery firms in Europe, as there was no local supply. Some European chemical firms with experience in power metallurgy decided to move into cathode active material production. BASF in Germany started to produce NMC for CATL in Germany, and Umicore started to produce for LG Energy Solutions in Poland and then for ACC and soon CATL. Korean and Chinese battery material firms have been fast to follow the expansion of Korean and Chinese battery producers in Europe. In Hungary, the Korean firm EcoPro has invested to supply Samsung, and Huayou Cobalt has invested to supply EVE Energy. PowerCo is trying to build its own supply chain with Umicore in Poland to supply NMC and IBU-tec in Germany to supply LFP cathode active materials. More recently, top Chinese firms want to establish factories in Europe. Ronbay (Poland investment) and Beijing Easpring (Norway investment) are globally leading firms, and XTC (co-investment in France) is also a top firm, which aims to supply battery firms in the French battery cluster. CATL is trying to build its LFP supply chain in Spain with Hunan Yenung, a top LFP supplier in which it owns equity.

The Chinese chemical conglomerate Wanhua is pursuing an assertive strategy to expand into battery materials, with a particular focus on investments in Europe. Wanhua began investing in LFP cathode active materials in China in the late 2010s and is now seeking new markets and customers as it competes with established Chinese LFP material suppliers.[40] More recently, the company has invested in a new LFP production facility at its chemical site in Hungary, where it previously acquired the Hungarian chemical firm BorsodChem in 2011. Wanhua is currently seeking partnerships with cell manufacturers to secure offtake for its LFP cathode active materials.[41] In 2025, Wanhua entered into a joint development agreement with the German chemical company IBU-tec to co-develop LFP cathode materials for the

[39] https://christopherchico.substack.com/p/why-korean-battery-makers-are-converting.
[40] https://www.energytrend.com/news/20250827-50079.html.
[41] https://borsodchem.com/en/articles/press-releases/borsodchem-is-building-a-new-cutting-edge-plant-in-kazincbarcika-unique-even-at-european-level.

European market. The two firms have already secured PowerCo's Salzgitter plant in Germany as their first off taker.[42]

In Morocco, an LFP supply chain is emerging driven by a wave of large-scale investments by Chinese firms. They leverage Morocco's Free Trade Agreement with the United States to access the US market. Gotion is investing in a 20 GWh battery cell manufacturing plant, and a joint venture between the Chinese cathode producer Huayou and LG Chem is focused on LFP cathode materials to supply the LG plants in the US.[43] In addition, Chinese cathode firm BTR has partnered with the Moroccan investment group Al Mada to produce LFP cathode material. The Moroccan government is actively seeking to leverage these investments by linking them to its state-owned conglomerate OCP Group, which is one of the world's largest phosphate fertilizer producers. OCP is seeking to supply phosphoric acid, positioning itself as a key input provider for LFP cathode active materials (Umar and Yang, 2025).

Table 5. Cathode active material producers in Europe, 2026

Country	City	Firm	Ownership	Status & Plant size	Chemistry	Confirmed customers
Hungary	**Debrecen**	**EcoPro**	**South Korea**	**Operational 2026, 80 GWh**	NMC	Samsung SDI & SK On (Hungary)
	Acs	*Huayou Cobalt*	*China*	*Under construction, 19Gwh (75Gwh potentially)*	NMC	EVE Energy (Hungary)
	Kazincbar-cika	Borsod-chem/Wanhua	China	Announced, 22 GWh	LFP	*ElevenEs, GIB*
Poland	**Nysa**	**Umicore**	**Belgium**	**Operational 2022, 30 GWh,** 40 GWh by 2028	NMC	LG (Poland) ACC (France) CATL (Hungary)
	Nysa	Ionway	Umicore (Belgium) & PowerCo (Germany)	Announced, expected 2030, 70 GWh	*NMC*	*PowerCo*
	Konin	*Ningbo Ronbay*	*China*	*Under construction, 15 GWh (75 GWh potentially)*	NMC (Plans for LFP)	
Germany	**Schwarz-heide**	**BASF**	**Germany**	**Operational 2023, 20 GWh**	NMC	CATL (Germany, Europe)

[42] https://www.faz.net/aktuell/wirtschaft/unternehmen/dieses-unternehmen-aus-thueringen-ist-deutschlands-batterie-hoffnung-accg-110726642.html. https://www.ibu-tec.com/investor-relations/financial-news/news-article/ibu-tec-advanced-materials-ag-signs-contract-with-powerco-se-for-the-production-of-battery-materials-with-a-targeted-volume-in-the-mid-double-digit-million-euro-range/.
[43] https://source.benchmarkminerals.com/article/lg-chem-huayou-cobalt-deal-reshapes-cathode-landscape-for-electric-vehicle-batteries.

Country	City	Firm	Ownership	Status & Plant size	Chemistry	Confirmed customers
	Weimar	**IBU-tec**	**Germany**	**Operational 2023, 2 GWh (12 GWh by 2028)**	LFP	PowerCo (Germany)
Finland	*Kotka*	*Easpring*	*China 70%, Finland 30%*	*Under construction, 45 GWh*	NMC	LG (Poland) SK On (Hunary)
	Vaasa	Freyr	Norway	Announced/on hold 15 GWh	*LFP*	*Freyr (Norway, US)*
France	*Dunkirk*	*Orana & XTC New Energy*	*JV France – China (49-51%)*	*Under construction, 20 GWh*	NMC	ACC or Verkor
	Dunkirk	Axens & Hunan Changyuan Lico	JV	Announced, 21 GWh	NMC	ACC or Verkor
Spain	Merida	Hunan Yuneng	China	Announced in 2024, 25 GWh	LFP	CATL-Stellantis (Spain)
Morocco	Jorf Lasfar	LG Chem & Huayou	JV South Korea & China	Announced, 42 GWh	LFP	LG (USA)
	Jorf Lasfar	COBCO CNGR & AL MADA	China Morocco	Announced, 45 GWh	LFP	
	Tanger	*BTR*	*China*	*Under construction*	NMC	US market
	Kenitra	*Gotion*	*China*	*Under construction, 10 GWH, vertically integrated cathode material-to -cell plant*	LFP	Gotion (Morocco)

Sources: Complied based on firm websites of cathode active material producers; 'IPCEI Batteries. Market Update Q4 2024'. (https://www.ipcei-batteries.eu/fileadmin/Images/accompanying-research/publications/2024-11-BZF_Kurzinfo_Marktanalyse_Q4-ENG.pdf)

In sum, regional supply chains seem to be emerging around battery production clusters. There is a Hungary/Poland supply chain for the Korean battery firms and the new Chinese battery cell factories, and smaller German and French supply chains emerging around the German battery factories and the northern France battery cluster. CATL is also creating a supply chain in Spain for its bigger factory there. There is a growing number of investments in LFP material production in Morocco. European cathode material production is still dominated by NMC, but there are some investments in LFP. Some firms like Umicore see where the market is heading and try to move into LFP in the future.

There is no significant anode active material production in Europe yet, perhaps because it is easier to transport (lighter and safer) than cathode active materials. Two Chinese firms Putailai and Shanshan planned factories in Sweden and Finland, respectively, but were cancelled, for different reasons. Putailai is a top firm in China. Its CEO William Chen worked with CATL CEO Robin Zheng at ATL. When Zheng bought out the ATL battery business from its parent Japanese firm TDK and started CATL, Chen left to establish Putailai, supplying anode material for Apple's products.[44] Putailai aimed to establish a 50 GWh factory in Sweden, but it was blocked by the Swedish Strategic Products Board (ISP) in late 2024. According to an interview, the Board made demands on the Chinese investment that Putailai declined and that the Chinese government would not have approved. Putailai had selected Sweden in order to use cheap, renewable energy and thus meet European battery regulations. According to our interviewee, it will probably still set up the factory somewhere else. Shanshan had planned a 50 GWh anode factory in Finland, but it was cancelled because Shanshan faced financial troubles. European firms like BASF and Umicore seem to want to avoid anode production in graphite anodes, which are seen as a commodity and are dominated by Chinese firms, and instead are investing in 'next generation' silicon carbon anode technology.

There are several European firms planning to produce anode material. Grafintec Oy, the Finnish subsidiary of the UK company Beowulf Mining which is mining graphite in Heinävesi, plans to start anode active material production in Finland. A site has been selected, but construction had not started as of March 2026.[45] Vianode, a Norwegian startup founded in 2021, is producing anode material but on a small scale (2 GWh). Vianode signed a long-term supply agreement with GM in January 2025, for which it is building a larger plant in Ontario, Canada.[46] The Australian mining firm Talga Group plans to produce anode material in connection with is mining of graphite near Luleå, Sweden. Initial plans announced in 2023 aimed for annual production of 20 GWh, but this has been downscaled and the start of production is uncertain.[47] There are three firms producing synthetic graphite in Europe: SGL Carbon in Poland, Imerys in Switzerland, and Tokai Cobex in France, which have considered entering battery-grade anode active material production but have not done so yet.[48]

In terms of the other two main battery material components – separator and electrolyte – there are several Korean and Chinese firms that have set up operations in Europe or are in the processing of establishing factories. These factories are mainly in the battery manufacturing clusters in Poland and Hungary, as shown in Table 6. Electrolyte solutions

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[44] Interview with the Managing Director of a battery materials company.
[45] https://www.powercoast.fi/en/front-page/karkitoimialat-of-the-region/power-coast-battery-cluster/.
[46] https://www.vianode.com/news/vianode-signs-usd-multi-billion-long-term-supply-agreement-for-ev-battery-grade-anode-graphite-with-gm.
[47] https://www.kuriren.nu/nyheter/lulea/artikel/talga-nekas-11-miljarder-i-stod-for-fabrik-i-lulea/r4p9pz9r.
[48] https://www.ipcei-batteries.eu/fileadmin/Images/accompanying-research/market-updates/2025-06-BZF_Kurzinfo_Marktanalyse_Q2_ENG.pdf

have a limited shelf life, making co-location particularly important, so electrolyte factories have been established near battery cell production facilities.

Table 6. Separator and Electrolyte Production in Europe, 2026

Country	Firm (ownership)	Battery component	Customer
Poland	LG Chem (South Korea)	Separator	Supplying LG Energy Solutions
	SK IE (South Korea)	Separator	Supplying SK On
	Enchem (South Korea)	Electrolyte	Near LG Energy Solutions
	Guotai-Harong (China)	Electrolyte	Near LG Energy Solutions
	Capchem (China)	Electrolyte	Supplying LG ES, Samsung SDI, PowerCo
Hungary	LG Chem (South Korea)	Separator	LG Energy
	W-Scope (South Korea, part of Samsung Group)	Separator	Mainly for Samsung SDI
	SEMCORP (China)	Separator	ACC,
	Enchem (South Korea)	Electrolyte	Near SK On
	Soubrain (South Korea)	Electrolyte	Samsung SDI, SK On
	Dongwha Electrolyte (China)	Electrolyte	SK On
	Kunlunchem (China)	Electrolyte	Under construction, plan to supply CATL, EVE & Sunwoda
Sweden	Senior Material (China)	Separator	Under construction, 60 GWh planned capacity
France	Enchem (South Korea)	Electrolyte	Near ACC, Verkor, AESC, ProLogium
UK	Mitsubishi Chemical Group (Japan)	Electrolyte	Near AESC
Germany	Lanxess (Germany), producing 'under the authorization' of Chinese firm Tinci	Electrolyte	*
	E-Lyte (Germany)	Electrolyte	*
Czech Republic	Central Glass (Japan)	Electrolyte	*

Note: *We could not confirm the customers for these plants.
Sources: Compiled based on firm websites of separator and electrolyte producers; 'Central Europe-East Asia EV Nexus Investment Tracker. Central European Institute of Asian Studies' (https://evnexustracker.ceias.eu/map), and data from VDI-VDE IT battery production market updates, accessed via https://www.ipcei-batteries.eu/accompanying-research/market-updates.

6. EU policies and the push for localization of the battery supply chain in Europe

The EU has adopted policies to electrify the transport sector since 2015, after the Dieselgate scandal and Paris Agreement commitments. However, the European auto industry has been slow to invest in electrification, citing the lack of public investment in charging infrastructure and purchase incentives to make EVs affordable. But the real bottleneck has been the decision by European carmakers to get as much value out of their existing internal combustion engine assets as possible before making the switch, hence their underinvestment in commercializing battery technologies and building a battery ecosystem (Whitfield and Wuttke 2025, 2026).

The European Commission's vice president and then energy commissioner Maroš Sefcovic launched the European Battery Alliance (EBA) in 2017. The objective of the EBA is to increase Europe's competitiveness in battery technology, to create a European lithium-ion battery cell industry, almost from scratch, that spans the whole supply chain, and to reduce dependence on Asian suppliers. The EU tasked EIT InnoEnergy with managing the Alliance and convincing industry actors to join forces and strategically invest and engage in projects that can advance this European battery supply chain (Saz-Carranza et al. 2021). European carmakers had preferred to import the battery cells they needed for their small EV fleet or have South Korean companies LG Chem or Samsung set up factories in Europe and buy batteries from them, rather than invest in the battery business in Europe, with the exception of VW. InnoEnergy tries to create a common commitment to building a European battery supply chain and to convince industry and financial markets to invest in battery projects and promising start-ups.

The idea of the EBA began when a group of former Tesla executives backed by a Swedish venture capital firm founded the battery startup company Northvolt in 2016 and approached InnoEnergy for support in creating the broader eco-system of suppliers and buyers that would be necessary for their startup to work (Näsman et al. 2026; Saz-Carranza et al. 2021). The leading Korean battery firms Samsung SDI, SK On and LG Energy Solutions and some Japanese firms had announced the construction of large-scale battery cell factories in Europe, and some European chemical firms such as BASF and Umicore started producing battery materials.

The EBA initially was envisioned as an Airbus-style consortium, like in the 1960s, when European firms struggled to take on American aviation competitors, but the Commission expected there to be 'several consortia working closely among themselves' (Saz-Carranza et al. 2021: 11). The Commission's Strategic Action Plan for Batteries used existing Horizon 2020 programmes to award €200 million for innovation and research on battery manufacturing projects between 2018 and 2020, and the Commission's vice-president Sefcovic encouraged member states to use the Important Projects of Common European Interest (IPCEI) tool to facilitate state aid. Two IPCEIs were granted with 3.2 billion Euros and 2.9 billion Euros of public funding to support the development of the battery ecosystem. The first project approved by the Commission in late 2019 involved 17 companies in 6 member states and was coordinated by France. The second project approved in early 2021 included 42 companies from 12 member states and was coordinated by Germany. The money for the projects comes from member states, including subsidies given to companies investing in battery production, which is allowed under the IPCEI framework. Firms that benefited included ACC in France, InoBat in Slovakia, Northvolt in Sweden, and battery material producers BASF and Umicore.

Other European frameworks that allow for state aid are the Temporary Crisis and Transition Framework (TCTF) and the Research, Development and Innovation (RDI) framework. The TCTF was Europe's response in 2023 to the US Inflation Reduction Act. It allowed member states to match aid available elsewhere so that an investment is not lost. Thus, battery manufacturing investments could be subsidized at the level of mass production. Northvolt in Germany received state aid under this framework, and Hungary received approval to pay state aid to battery firms under this framework, including to CATL. The RDI allows state aid for R&D.

These three EU policy measures (IPCEI, TCTF, and RDI) just provide the rules for the conditions under which member states can subsidize firms despite the general ban on state aid in the EU. None of the money comes from the EU budget. Actual EU budget money that firms can access is rather limited. The main sources are grants from the European Innovation Fund and loans from the European Investment Bank supported with EU budget guarantees as well as some funding from the EU Horizon budget through measures such as BATT4EU and EIC STEP Scale Up. These policy measures and examples of firms that have benefited from them are listed in Table 7.

Some member states have made active use of the EU policy measures, mostly notably the French government, which supported the emergence of a battery cluster near Dunkirk and the existing automotive industrial cluster in the region. The cluster has six battery manufacturers investing in it: ACC, Verkor, AESC-Envision, ProLogium, Blue Solutions and Tiamat. The French government has used multiple EU policy measures to attract and support these firms including regional aid, IPCEI subsidies, RDI subsidies as well as the EU Innovation Fund and InvestEU. The French government used the provision of emergency loan guarantees to Renault and Stellantis in 2020 as leverage to force these French and partially French carmakers to make more investments in EV production and technological indigenisation of EV battery technology in France (Ban and Liu 2025). Having Renault and Stellantis as the anchor firms, the French government sought to build an EV ecosystem through local and foreign investments, coordinated through typical French institutions for public-private coordination (Le Comité Stratégique de Filière Automobile).

The EBA was essentially an alliance of northern European governments that wanted to push European battery startups, especially Northvolt. According to an interview with InnoEnergy, Hungary was not involved in the Battery Alliance, and its strategy of attracting South Korean and then Chinese battery manufacturers with subsidies under the regional aid framework went against the EBA's strategy of supporting European-owned battery firms.

Table 7. EU policy measures with relevance for the EV power battery value chain

Policy instrument	Responsibility	Concrete measures	Examples of firms that received it
Regional aid	European Commission (EC) governance; member state funding	Subsidies for potentially anything (incl. battery material or cell manufacturing plants)	Samsung SDI in Hungary; LG in Poland 2019/2022; SK On in Hungary 2021/2022; Sunwoda in Hungary; Toray (separator film) in Hungary; AESC in France
IPCEI: subsidies for R&D and first industrial deployment	EC governance; member state funding	Subsidies for R&D and first industrial deployment in predefined strategic technologies (two IPCEIs for batteries have been approved, covering battery materials, battery cell production, battery assembly, and battery recycling)	Battery cell producers: ACC in France, InoBat in Slovakia, Northvolt in SWE/GER; Battery material producers BASF and Umicore
TCTF/CISAF: subsidies for production facilities	EC governance; member state funding	Subsidies to mass production in green tech manufacturing (incl. battery material or cell manufacturing plants)	Northvolt in Germany; Hungary has also received approval to give out state aid under TCTF to battery firms (unclear which exactly); CATL is reported to receive €800mn subsidies for its battery plant in Hungary
RDI: subsidies for R&D	EC governance; member state funding	Subsidies for R&D in potentially anything as per the RDI framework (incl. battery material or cell firms)	ProLogium in France; Verkor in France
EU Innovation Fund	EC, using money from the EU Emissions Trading System	Direct grants for capex and opex in innovative battery cell manufacturing projects of overall €3bn to be disbursed 2024-2026	Six projects were announced in July 2025 receiving a total of €852mn: ACC; Verkor; Cellforce; NOVO; Leclanché; LG
InvestEU	EC and EIB and national banks	Uses an EU budget guarantee to mobilize private investment (incl. for battery investments) by working with the European Investment Bank (EIB) Group and national promotional banks	Over the years 2019-2024, €6bn in financing were provided to the EU battery value chain: €400mn loan to Verkor; €943mn to Northvolt in 2024 and some earlier loans since 2018
BATT4EU	Co-governed by the Batteries European Partnership Association and the EC; funding	Grants for R&D in next-generation battery technology; small grants in the one to two digit millions, disbursed via various calls, see here	Does not fund individual firms, but consortiums

Policy instrument	Responsibility	Concrete measures	Examples of firms that received it
	from EU Horizon Europe budget		
EIT InnoEnergy (venture capital fund)	Independent venture capital company, but receives funding from the EU Horizon Europe budget since 2010	Capital (mainly equity funding it seems) for green ventures, incl. battery material and battery cell firms; but it is almost impossible to find actual investment sums per company	Northvolt; Verkor; Basquevolt; >20 more less known firms in the battery value chain
EIC STEP Scale Up	Administered by the European Innovation Council (EIC), an entity under the EC, with Horizon Europe funding	Equity-only investments to startups, SMEs, and small mid-caps, between €10 to 30 million; Total 2025 budget of €300mn (batteries qualify as a 'clean technology')	11 firms selected so far (no battery value chain firms so far)
Net-Zero Industry strategic project status	EC provided the application guidelines; the EU country where the project is located assesses the application	Status provides the project with a priority status for accelerated administrative treatment and faster permitting	8 firms selected so far, including two battery firms: Exeron X-BESS in Bulgaria and Talga Battery ANODE Refinery ONE in Sweden

Sources: European Commission (https://ec.europa.eu/newsroom/comp/items/778522; https://ec.europa.eu/commission/presscorner/detail/en/ip_19_6705; https://ec.europa.eu/commission/presscorner/detail/en/ip_23_3851; https://ec.europa.eu/commission/presscorner/detail/en/ip_25_1727; https://ec.europa.eu/commission/presscorner/detail/en/statement_24_6201; https://eic.ec.europa.eu/news/first-companies-put-forward-major-investments-under-eic-step-scale-scheme-2025-04-03_en; https://single-market-economy.ec.europa.eu/industry/sustainability/net-zero-industry-act/strategic-projects-under-nzia/overview_en)

The EU Critical Raw Materials Act in effect since May 2024 has the goal of boosting the supply of critical raw materials and strategic raw materials by 2030 (Tröster et al. 2024). A material is assessed as strategic based on its significance for the green and digital transition or for defense and aerospace.[49] Lithium is considered a critical raw material since 2020, and battery-grade lithium as a strategic raw material since 2023.[50] The Act introduced benchmarks: EU extraction capacity meets 10 percent of annual strategic raw material consumption, considering reserves; EU processing capacity covers 40 percent of annual consumption; EU recycling capacity handles 25 percent of annual consumption and increases recycling from waste; and no third country should account for more than 65 percent of

[49] The EU Commission designates SRMs, given that it is a primarily a political decision to classify technologies as strategic. Details about the underlying data and calculations of the SRM metrics are not published in the CRMA.
[50] While all types of lithium qualify as critical, only the high purity refined lithium is defined as strategic, typically lithium carbonate or lithium hydroxide.

imports for the EU's annual consumption. These benchmarks exclusively apply to strategic raw materials and are non-binding.

A key instrument introduced by the Critical Raw Materials Act is the Strategic Project, which is defined as a project aimed at strengthening the EU's security of strategic raw material supply. The key prerequisites are that Strategic Projects involve mining, processing, or recycling (but not exploration) of strategic raw materials. The projects may be conducted in EU member states as well as in third countries. Strategic Projects are granted the "public interest" status due to their contribution to the security of supply of strategic raw materials in the EU, which allows acceleration of the permit-granting process and the environmental impact assessment procedure. The Strategic Project status does not imply direct financial incentives, as the Act does not create a new European financing instrument.

The EU Battery Regulation which was passed in 2023 and sets lifecycle sustainability, safety, and transparency rules (including carbon footprint, recycling, and due diligence) for all batteries placed on the EU market was intended indirectly to support the localization of battery materials and components production by setting high environmental requirements. According to an interview with InnoEnergy, the EBA was involved in writing and making recommendations for the regulation. The Alliance thought that making demands on recycling and the use of green electricity in production would create an incentive to localize production in Europe, especially in EU countries with high renewables shares, and a barrier to entry against Asian battery firms with laxer environmental credentials. However, this proved not to be the case. According to the interviewee, CATL tracked the Battery Regulation from the very beginning, had very competent people in governance and in Brussels, and set up green factories in China with recycling and renewable energy. They are now better able to fulfil the criteria of the regulation than any of the European battery firms, according to the interviewee.

Notably, the EU Battery Regulation had encouraged Putailai, the largest Chinese anode manufacturer, to establish a factory in Sweden where it could access cheap hydroelectricity. According to an interview with a different anode producer, Putailai thought it would be a competitive advantage to be green and local, compared to other anode firms. However, the recently established Swedish Strategic Products Board placed significant demands on the foreign direct investment by Putailai, which the latter refused to accept and arguably would not be accepted by the Chinese government, which must grant approval for overseas investments. The demands included majority Swedish management and control over the intellectual property. These demands are similar to those being put forward in the EU's Industrial Accelerator Act.

The European Commission published the proposal for the Industrial Accelerator on 4 March 2026.[51] The Industrial Accelerator Act aims to use public procurement and access to subsidies to ensure secure some markets for European production in strategic industries (energy-intensive industries, net-zero technologies, and the automotive industry) by making low-carbon and 'Union origin' requirements. The 'Union origin' requirement is about production location and not firm ownership, i.e. battery cells made by Chinese firm CATL in Hungary will equally count as 'Union origin' as those made by the German firm PowerCo in Germany. In addition, union origin includes content originating in third countries with which the Union has concluded an agreement establishing a free trade area or customs union. The IAA further allows derogations of the requirements by member states under certain conditions, such as where compliance would raise costs significantly (around 25–30%) or where supply constraints exist.

The Act also puts restrictions on foreign direct investments that exceed EUR 100 million in emerging strategic manufacturing sectors, where 'more than 40 percent of the global manufacturing capacity is held by the third country of which the foreign investor is a national or undertaking'. The named strategic sectors are battery technologies, pure electric vehicles, solar PV technologies and extraction, processing and recycling of critical raw materials. Again, this does not apply to investors covered by economic partnership and free trade agreements. It is clear from this specificity that the legislation targets investments from Chinese firms. Such foreign direct investments would require approval by an Investment Authority set up in the Member State to implement this Act. Furthermore, foreign direct investments affected by the criteria described above must meet several conditions, which emphasize joint ownership, with the foreign investor having not more than 49 percent ownership, and agreements providing for the licensing of their intellectual property rights and of their know-how to the benefit of the joint venture firm.

Thus, the Act shows the European Commission's ambition to support local production in Europe, but there could be waivers and there is no protection for European firms against Asian firms producing in Europe. What is more, the market for publicly procured EVs which the IAA covers is small, and most Chinese battery investments will already have concluded by the time the IAA will come into force in a few years. A more significant opportunity might emerge from the fact that public procurement for battery energy storage systems connected to national grids seem to have security clauses that prevent Chinese firms from participating in the bids, giving European startups a protected market through which to build capabilities and scale. As several interviews pointed out, European-owned battery firms are increasingly targeting the energy storage market segment, as well as battery cell production for defence and security-related end markets, which could have similar clauses.

[51] https://single-market-economy.ec.europa.eu/publications/industrial-accelerator-act_en

Many EU member states have supported EV uptake via consumer purchase subsidies and tax incentives. However, these policies are fragmented across member states and often unstable.[52] In the largest member state, Germany, the cancellation of such subsidies in late 2023 led to a sharp decline in EV sales in 2024. More recently, EV purchase subsidies have been reintroduced in Germany in January 2026, but the effect remains to be seen. Incentives for charging infrastructure as well as public investment in it have been especially meagre.[53] Thus, overall, European policy has done relatively little to support the demand side compared to demand-side policies implemented in China. How this develops going forward will determine the development of EV sales in Europe, and whether European EV demand will grow rapidly enough to fill the currently planned EV and battery production and further expansions.

7. Central and Eastern Europe at the center of EV battery production

The economies of the Czech Republic, Hungary, Poland and Slovakia are heavily reliant on the automotive sector, as central nodes in regional and global automotive chains. Regionally, their industries are centered around Germany and built on foreign investments that were dominated by German companies. In fact, they were key to the German carmakers' strategy of remaining competitive amidst increasing global competition in the 1990s and 2000s. Japanese and South Korean automakers invested in these countries following their accession to the EU to access the European market and circumvent trade barriers. Carmaker investments in assembly in these countries were followed by investments from their international automotive suppliers (Pavlínek 2018, 2025). The shift towards EV production by existing factories in Eastern Europe and greenfield investments in EV production started in 2020 (Pavlínek 2023). As shown in Table 8, most of the existing car assembly factories in Eastern Europe are producing some battery EVs or plan to do so by 2027. The outliers are the Japanese firms, which are only producing hybrid cars (not plug-in hybrids).

The Czech Republic has the largest automotive industry in the region (CEIAS 2025). The Czech government does not have a national strategy to attract EV or EV battery investments, but given that it has a large automotive industry, carmakers in the Czech Republic, Hyundai and Skoda (Volkswagen Group), started producing EV models. The EV shift of these carmakers created a demand that was large enough to pull battery and battery material investments. South Korean battery firms looked at the Czech Republic first, but when the government did not offer them investment incentives, they decided to invest in Poland and Hungary instead, where the governments offered state aid. This location pattern indicates

[52] https://www.acea.auto/fact/electric-cars-tax-benefits-and-incentives-2025/.
[53] Ibid.

that it is not necessary for EV battery cell producers to co-locate with EV assemblers in the same country. Locating in nearby countries is sufficient given the size of European countries. This trend also means that there is scope for government policies to influence the geography of battery cell producer investments and thus shape battery clusters in their own countries, which is what Poland and Hungary have done.

Table 8. Overview of EV Production among Carmakers in Eastern Europe

Country	Carmaker	Location of factory	EV production	EV Production Status/SoP
Czech Republic	Volkswagen/Skoda	Mladá Boleslav	Battery EV models	2020
	Hyundai	Nošovice	Battery EV models	2020
	Toyota	Kolin	Hybrid cars	2021
	Toyota	Kolin	Battery EV models	Planned for 2028
Poland	Stellantis	Tychy	Partnership with Leapmotor cancelled	No EV production
	Volkswagen	Wrzesnia	Commercial EVs	Planned for 2027
Hungary	Mercedes-Benz	Kecskemét	Battery EV models	2021
	BMW	Debrecen	100% Battery EVs	2026
	Audi	Györ	PHEVs	2023
	BYD	Szeged	100% Battery EVs	Planned for mid-2026
	Suzuki	Esztergom	Hybrid cars	2013
Slovakia	Kia (Hyundai Group)	Teplicka nad Vahom	Battery EV models	2025
	Volkswagen	Bratislava	Battery EVs models	2013 with the e-Up model; 2023 with Porsche Cayenne E4
	Stellantis	Trnava	Battery EV models	2024
	Volvo (Geely)	Valaliky	100% Battery EVs	Planned for 2027
Slovenia	Revoz (Renault)	Novo Mesto	Battery EV models	2026

Source: Created by the authors with data from company websites.

The Polish government strategy focused on attracting South Korean battery firms but also tried to launch its own EV carmaker through a partnership with Volvo (Geely). This effort stalled, but in mid-2026 the state-owned company ElectroMobility Poland announced it would enter a joint venture with Taiwanese electronics giant Foxconn to manufacture local brand EVs. The Hungarian government strategy focused only on foreign direct investments, along the EV supply chain, attracting Korean and Chinese investments. Poland does not have strong EV assemblers, but it has a strong EV battery chain, with LG Energy Solution at the centre, which exports to EV assemblers in the region. Hungary has more carmaker investments, and thus they are also an important driving factor in attracting Korean and Chinese EV battery cell producers. Slovakia illustrates yet another trend. The Slovakian government initially did not have a strategy to attract EV investments. Its major carmaker was Kia (Hyundai Group), but it attracted an investment from Volvo in a greenfield factory and supported the local firm InoBat and its joint venture with Chinese battery cell producer Gotion to start a battery cluster.

This section examines these different trajectories of the four countries, focusing on government strategies and carmaker strategies. For Hungary, we draw on primary material collected during interviews in Hungary in November 2025. For the Czech Republic, Poland and Slovakia, we draw largely on the CEIAS 2025 report, combined with some interviews, as we could not undertake fieldwork in these countries yet.

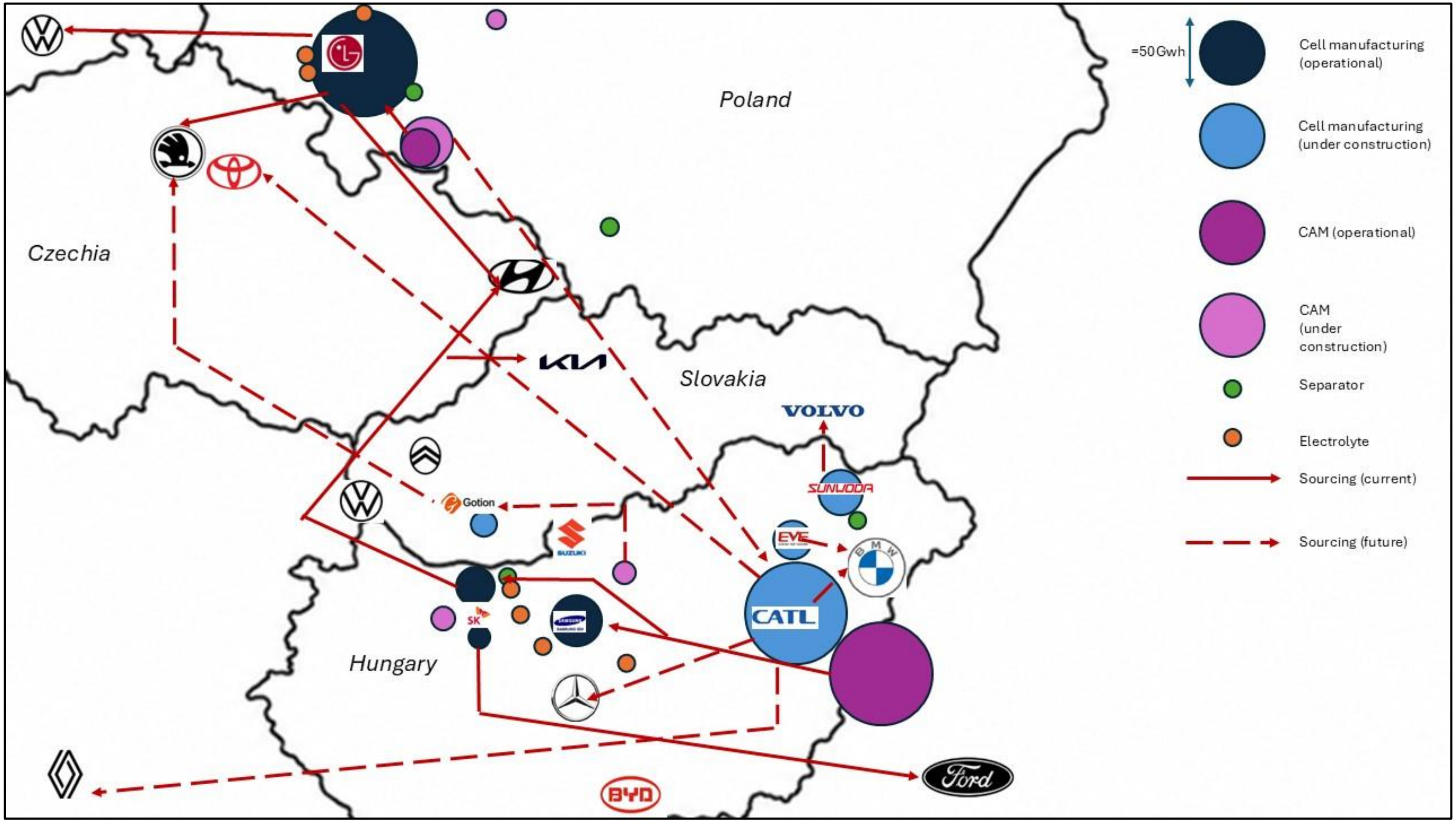
Table 9 summarizes the overall trajectory for the CEE countries. Poland has an EV battery cluster based on the first mover strategy of LG Energy Solutions. Hungary has an EV battery cluster based on the government's aggressive FDI attraction strategy. Czechia has EV production without a battery cluster, which is served by the battery production in Poland and Hungary. Battery cell manufacturing does not necessarily require the co-location of EV assembly plants in the same country, given the relatively small distances between countries in the CEE region. In contrast, electrolyte, cathode active material (CAM), and separator production tend to cluster around battery cell manufacturing facilities. Slovakia has some EV battery production in response to local firm effort rather than a government strategy. Figure 4 provides a visual summary of the emerging EV battery ecosystem.

Table 9. Summary of the EV & EV battery developments in the CEE region

	Poland	**Hungary**	**Czechia**	**Slovakia**
Battery cell production capacity, current (under construction)	86Gwh	87Gwh (+117) Gwh	0GWh	(+20Gwh)
Overall trajectory	**Battery cluster based on first mover strategy**	**Battery cluster based on aggressive FDI attraction**	**EV production without batteries**	**Battery production in response to local firm effort**
East Asian battery firm strategy	LG uses Poland as EU core base, early mover	Samsung and SK use Hungary core base, early mover Chinese firms piggyback on existing battery ecosystem & see Hungary as entry point for Europe	Korean firms sought to invest but no government strategy No option for Chinese firms due to geopolitical factors	Chinese firm partners with local firm (Gotion-InoBat) to access European market
State industrial policy on battery manufacturing	Support of LG to pull in investment	Aggressive FDI promotion for South Korean, and later for Chinese firms	Weak policy, sought to attract German and South Korean battery investments but unsuccessful	Initially no battery policy; Later support of local firm and EV industry (Volvo)

Source: Created by the authors.

Figure 4. EV battery ecosystem in Central and Eastern Europe



Sources: Created by the authors.

Unlike the other countries in the region, the Czech Republic has not received new investments linked to EV or EV battery production, but rather carmakers repurposed their existing factories and expanded them to produce EV models. Hyundai launched the Kona battery EV model in 2020 to meet the high demand for EVs at the time. Since then, it also launched the Tucson PHEV and hybrid models. Thirty percent of its factory is used for EV production, and it aims to increase it to 50 percent. The Hyundai factory sources battery cells from LG Energy Solution in Poland, which are assembled into battery packs by Hyundai Mobis, a subsidiary company of Hyundai that was spun off into an independent company. Skoda, of the Volkswagen Group, introduced EV models around the same time as Hyundai, and sourced its battery cells from LG Energy Solution and assembled the battery packs in-house. The Chinese firm Minth was looking to invest in the Czech Republic in 2021, to produce battery casings, but the government rejected its request for investment incentives. According to the CEIAS report, Minth invested anyway, supplying Skoda. The CEIAS report notes that the Czech government was in talks with Samsung SDI regarding building a battery cell factory but given the current challenges that Samsung SDI's factory in Hungary is facing (see below), these talks are probably on hold.

The Polish government that came to power in 2015 adopted a proactive approach to attracting investments in innovative activities, creating the Strategy of Responsible Development in 2017, and declared electromobility as one of its priority sectors. The CEIAS report notes that the government saw South Korea as a role model. LG Energy Solution became the anchor investor of a battery cluster, making Poland the second largest battery producer and exporter in the world after China in 2025. The LG Group was present in Poland already, producing products for consumer electronic goods since 2006. In 2016, it invested in a battery cell factory, which was completed in 2017 and then immediately expanded and again in 2019 and 2021. It benefited from state aid for each of the four investments.

LG's battery factory attracted battery active material investments from Asian and European firms. Umicore established a NMC cathode factory in 2020, while SK High-Tech established a factory for separators and Guotai-Huarong established a factory for electrolytes. In 2022, SK Nexilis invested in a factory to produce copper foil. In 2024, Ningbo Ronbay New Energy Technology acquired a British chemical company and invested in making it a cathode materials factory. LG seems to rely on a Chinese battery material supply chain for material innovation, as its materials innovation is done in China. For example, LG is setting up its pilot plant for new sodium batteries in China.[54] The CEIAS report notes that LG ES faced declining demand in 2024 due to falling demand in Germany after the subsidies were removed and higher energy prices, and so it started diversifying into battery energy storage products. OEC export data at Poland country level suggests that LG took a hit in 2024 (Figure 5). As LG is the

[54] https://battery-news.de/en/2026/01/22/lg-energy-solution-prepares-pilot-production-of-sodium-batteries/.

only cell producer in Poland, Poland's battery exports equate to LG's exports. The fall in demand may also track carmakers' shift to LFP batteries.

In Slovakia, the existing carmakers announced plans to transition to EV production in the early 2020s, except for Volkswagen, which was already producing a low-cost compact electric vehicle since 2013. Greenfield investments were made in the early 2020s by Volvo, for a factory only producing battery EVs, and by Gotion InoBat Batteries (GIB) to produce LFP batteries. According to the CEIAS 2025 report, the Slovakian government built a dedicated industrial park for the battery factory and provided state aid. GIB has contracts secured with Volkswagen, which has an equity stake in Gotion.

Inobat is a local firm in which the investment in batteries was driven by its founders, and not by government policy.[55] The CEO Martin Bocek lived in the US and worked in investment and international development finance. He used his investment company to start Inobat in 2019 and leveraged his transnational networks to secure further financing as well as initial knowledge in battery chemistry by linking with US and Taiwanese companies and hiring international experts (Toplišek 2024).[56] Inobat's initial business strategy to focus on high performance NMC pouch batteries for niche markets failed, because it was dependent on one buyer that went bankrupt. Since then, it diversified its business strategy.[57] Using the lab and pilot production line that it set up initially, it continued to focus on battery R&D. Currently, InoBat is partnering with Altris, to scale-up battery production based on Altris' sodium-ion battery chemistry for Clarios, the customer. InoBat also shifted from EV batteries to battery energy storage systems, taking the decision that it could not compete with Chinese EV battery cell producers given that it lacked the necessary manufacturing capabilities. InoBat invested with Gotion in its Slovakian battery cell factory, hence the name Gotion InoBat Batteries, but the two firms remain distinct. InoBat has an equity investment in GIB but does not participate in its management, and Gotion made an equity investment in InoBat, providing an important source of capital. Gotion provides advice to InoBat on its battery energy storage system production but does not participate in the management. Thus, there are indirect knowledge spillovers from Gotion to InoBat, but GIB is not a joint venture in the sense of joint management, with the learning opportunities that such joint management provides. However, GIB is staffed primarily with Slovakian employees, which provides another opportunity for indirect knowledge spillovers.

In Hungary, the existing carmakers Mercedes-Benz and Audi were gradually introducing EV and PHEV models. BMW made a greenfield investment in a factory only for EVs, the iX3

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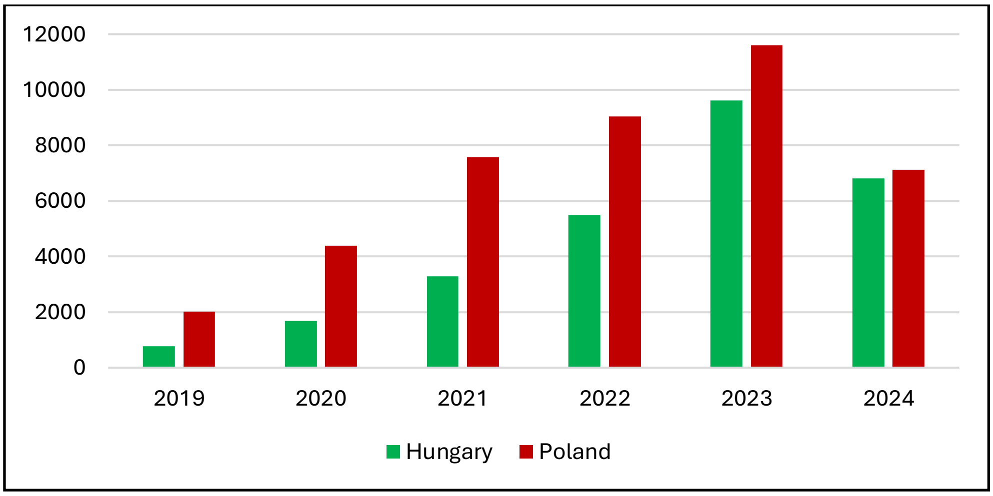
[55] Interview with CEO Marian Bocek on a podcast, 25 September 2025, accessed at https://open.spotify.com/episode/2ltNGAwUXWCWzKdwv7TlIi?si=XsX-J1XsQRO4uRzNw2oqOw.
[56] The leveraging of knowledge was confirmed in an interview with the COO of Inobat, 12 March 2026.
[57] Interview with the COO at Inobat, online, 12 March 2026; interview with the Director of R&D at InoBat, online, 21 July 2026; interview with the Managing Director of Gotion InoBat Batteries, online, 9 July 2026.

model, in 2019/20, but construction was delayed by the Covid-19 pandemic, and it only started operating in autumn 2025. The other greenfield investment is by BYD, which already had an electric bus assembly factory and a small battery assembly factory serving it. The BYD plant will start with a volume of 100,000 vehicles per year and plans to reach 300,000. Mercedes-Benz has expanded its factory in Hungary with a €1bn investment, with plans to eventually produce 400,000 vehicles per year.[58]

The Hungarian government has attracted significant investments in battery manufacturing by South Korean and Chinese battery cell producers. Although many factors attracted these Asian battery producers to the region, our interviewees seem to agree that they chose Hungary because of the government's significant investment incentives. We calculated, based on European Commission reports on state aid, that the Hungarian government has provided $4.2 billion in state aid, of which two-thirds involved direct grants to firms and one third was used to provide infrastructure related to EV battery investments. As a result, Hungary's export of batteries increased significantly and by 2025 it had become the second largest battery exporter in Europe, behind Poland (Figure 5). The 2024 drop is explained by the struggles of the Korean battery firms, as discussed above, and the fact that none of the Chinese firms are operational yet. Table 10 shows the current battery product portfolio and customers of the battery manufacturers in Hungary.

Figure 5. Hungary's and Poland's exports of Lithium-ion Batteries (million USD)



Source: Created by the authors. Data from OEC (2025). (https://oec.world/en/profile/hs/lithium-ion-batteries)

[58] https://www.automotivemanufacturingsolutions.com/factory-transformation/electric-c-class-and-small-g-class-enhance-kecskemet/2698542

Table 10. Overview of EV Battery Cell Manufacturers in Hungary, 2026

	Samsung SDI	SK On	CATL	EVE Energy	Sunwoda
Start of production	2017	2020	Late 2026	2027	2027/28
Production capacity	40 GWh	17 + 30 GWh	40 + 40 GWh	30 GWh	17 + 18 GWh
Battery cell type	Prismatic NMC	Pouch NMC	Prismatic 80% NMC 20% LFP	Cylindrical NMC	Prismatic NMC & LFP
Customers	VW (EUR) BMW (GER, until recently)	VW (EUR) Mercedes (HUN) Ford (GER) Ford (ROM) Kia (SK) Hyundai (CZ)	Mercedes (HUN) BMW (EUR) VW (EUR) Toyota (CZ) Renault (SVN)	BMW (HUN)	Volvo (SK)

Source: Created by the authors with data from interviews in Hungary.

Samsung SDI was the first battery investment in 2017, then SK On in 2020. They pulled in investments from their battery material suppliers. As discussed above, South Korean battery firms were looking to expand in the US and European market, especially as they were kicked out of the Chinese market during this period (2016-2019) with the Chinese government's Battery Whitelist that privileged Chinese battery producers. Our interviews indicate that the South Korean battery firms came to Europe because they were looking for new markets. Samsung SDI and then SK On put their factories in Hungary because of the investment incentives offered by the Hungarian government. These battery firms delivered to carmaker plants in Germany and Eastern Europe. Their presence might have facilitated the introduction of EV models by carmakers with factories in the Central and Eastern European region, as was the case with LG's investment in Poland.

The success of the Samsung SDI and SK On investments led to high level political support in the Hungarian government for the EV battery industry, buttressed by optimistic expectations of increasing EV demand in Europe. Thus, just at the time that Chinese battery firms were looking to open factories in Europe, the Hungarian government saw batteries as the new growth engine, adopting the National Battery Industry Strategy in 2022. The government gave battery investments the label of 'investment of strategic national importance', which requires the local authorities to speed up the permitting process, and it offered extensive state aid to investors (Éltető 2024).

The investment incentive includes a cash grant calculated by the government combined with the expected tax reduction, as the corporate income tax is reduced from 9 percent to 1.8 percent over 13 years. For the less developed regions in the southern part of Hungary, this amount can add up to 50 percent of the investment volume, and for higher developed regions in the West, it is slightly lower, around 30 percent. The government's assumption was that the subsidies would be refinanced through higher income from the local industry tax and wages. The Hungarian Investment Promotion Agency is also a very professional investment promotion agency that provides a 'one-stop-shop' for investors, and the state-owned company, INPARK-NIPUF Group, builds the infrastructure and industrial parks for the foreign investors.

Many commentators noted that the Chinese battery firm investments by CATL, EVE Energy and Sunwoda were driven by demand from European carmakers, as the Chinese firms had clear off-taker agreements with a specific carmaker. For example, EVE Energy came to Hungary to supply the BMW plant. However, it is also the case that the Chinese government requires such agreements before approving outward foreign direct investment as a precondition, to combat capital flight. Thus, EVE Energy and CATL are building factories in Debrecen to supply the BMW plant, and Sunwoda has plans to supply the Volvo plant in Slovakia. We know that they have also been pulled to the European market by the intense competition in the Chinese market that is resulting in price wars and driving down profits for EV producers and EV battery producers. Thus, they saw the European Union as the next largest market outside of China. They invested in Hungary because the government offered significant subsidies and because the Chinese government and the Hungarian government have very good relations. BYD will likely import the entire battery pack for passenger cars from China. It seems that BYD does not face the same incentives to localize battery production in Europe because it is its own customer, unlike CATL, EVE Energy and Sunwoda who invested in Europe to cater to European carmakers' preferences.

The Korean battery firms were feeling the competitive pressure from Chinese battery imports even before the new Chinese battery factories in Hungary, and in Hungary, they are also losing to the Chinese firms. For example, the new BMW factory in Debrecen for the iX3 model is sourcing NMC prismatic cells from the CATL factory in Debrecen and it will source NMC cylindrical cells from EVE Energy, which is constructing a factory literally right next door to the BMW factory. In response, Samsung and SK, as well as LG in Poland, are diversifying their form factor and their battery chemistry, to be able to offer more products and attract carmakers in the lower cost segment as well. Carmakers seem to prefer the prismatic battery cell type and increasingly prefer LFP. As Table 9 shows, the Chinese firms have a different portfolio than the Korean firms, which now are in a position of having to catch up. It will take them several years to change the machinery in their factories and to master the production of LFP prismatic.

Table 11 gives an overview of the battery supply chain that is emerging in Hungary. According to our interviews with the Asian battery manufacturers in Hungary, most of them are sourcing from both Korean and Chinese suppliers located in Hungary and the broader Central/Eastern

European region. CATL will initially source from China but indicated that it planned to source from suppliers in Europe. Producers of NMC cathode active material are present in Hungary, and a supplier of LFP is on its way. There are also suppliers of separators and electrolytes, but not suppliers of anode active material, which reflects the general European pattern discussed in section 4. There are also other battery component suppliers, as listed in Table 11, and one battery recycling firm.

Table 11. Overview of battery component manufacturers in Hungary, 2026

Cathode Material	Anode Material	Separator	Electrolyte	Recycling	Other related components
Bamo, subsidiary of Huayou Cobalt (CH)—NMC CAM EcoPro (KOR)—NMC CAM Wanhua (CH)—LFP CAM	*None*	Semcorp (CH) LG Chem (KOR) W-Scope (JAP)	Kunlun (CH) Dongwha (KOR) Enchem (KOR) Soulbrain (KOR)	SungEel HiTech (KOR)	Nippon Paper (JAP, additives) Shinheung (KOR, cover lids) Volta Energy (KOR, copper foil) INZI Controls (KOR) Doosan (KOR; copper foil) Bunchum (KOR, aluminum battery connectors)

Source: Created by the authors with data from interviews in Hungary.

Pollution problems at the Samsung SDI battery factory led to political protests (Ricz and Éltető 2025). The factory was previously the site for its TV production, and it was not suitable for battery production, which led to cathode material being released into the air and the water. This led to the topic of battery factories becoming very politicized. The government responded with regulatory changes, and the Samsung SDI factory resolved most of its problems. The government passed stricter environmental regulations. Before the tightening of the regulations, there were some guidelines, but they were not very strong and enforcement was non-existent, according to one of our interviewees. There was agreement among the interviewees that enforcement is stricter now, and that the Chinese firms are accepting this approach, as they follow the instructions. However, our interviews also confirmed that the European permitting process is restrictive in that factories must declare exactly what they will produce and how, after which they are given a permit for exactly these parameters. There is no flexibility in terms of changing the factory layout and production later. Chinese firms were used to making decisions as they go, which gives them more flexibility in responding to market changes and other shocks.

Given public opinion on battery factories and the saturation of battery investments in Hungary, the Hungarian government is no longer seeking to attract EV battery investments. There is no more space for battery cell producers, as the grid is being expanded to accommodate the already announced investments. The Hungarian investment promotion agency is now focused on research and development and gives subsidies to firms that invest in research and development activities.

8. Conclusion

The geography of Europe's vehicle production is in flux, driven by the shift from internal combustion engines to electric vehicles. Chinese EV makers, leaping ahead both technologically and in terms of cost competitiveness, put pressure on Europe's existing production networks, which have long been dominated by European, US, South Korean and Japanese legacy automakers. At the heart of this transformation is battery manufacturing, as battery cell production and battery active materials (cathodes, anodes, electrolytes, and separators) account for up to 50 percent of an EV's total value. With Chinese and South Korean firms dominating battery chemistry innovation, cell manufacturing, and battery pack assembly, Europe is falling behind in EV innovation and value capture. These combined pressures have catalyzed a wave of industrial policies across Europe aimed at capturing a share of the emerging battery cell and component production networks.

The emerging geography of battery production in Europe shows considerable variation both across and within regions. A Northern and Western European battery production network began taking shape in the late 2010s, initially driven by European battery startups supported by government industrial policies. However, many of these announced investments were subsequently downscaled or cancelled, and some European battery startups went bankrupt. In Central and Eastern Europe, investments have been driven primarily by leading South Korean and Chinese battery firms.

However, there is significant variation within the CEE region. By 2025, Poland and Hungary were the second and third largest battery exporters globally, while Czechia and Slovakia, the two largest automotive exporting countries in the region by vehicle numbers, have developed little to no battery production capacity. Differences in government industrial policies in response to Asian firms' business strategies were the main factor shaping the divergent outcomes in battery investments.

Emerging battery cell production clusters in Europe are both responding to the existing automotive production geography and reconfiguring that geography in the context of the shift to electric vehicle production. The CEE region was integrated into the European automotive industry as Western European automakers moved to lower production cost locations in the 1990s in response to increasing global competition. This shift produced a specific division of labor within Europe's macro regional automotive production network. High-volume, entry-level vehicle production shifted from France and Italy to CEE, while Germany focused on the premium segment. CEE government policy was limited to liberalized labor markets, infrastructure investments, providing EU market access, and direct investment incentives on assembly plants. As a result, CEE automotive sectors were peripheral and dependent, specializing in labor-intensive components and final assembly, with marginal local ownership and few strategic decision-making and innovation happening in CEE (Pavlínek 2018, 2025)

This automotive production geography in the CEE region attracted South Korean and then Chinese EV battery investments. However, there is a fundamental difference between the ICE production geography and the emerging EV production geography in the CEE region. Batteries are the locus of innovation in an electric vehicle, and EV battery production is still in the pre-paradigmatic stage of technological change (when a dominant design has not yet emerged). Thus, foreign investments in battery cell production and battery active materials hold a different potential for technological catch-up than ICE automotive assembly factories did in the past. This is particularly the case since the biggest EV battery clusters currently exist in CEE and not in Western Europe, the traditional 'core' of Europe's auto industry (Pavlínek 2025). This situation puts CEE countries closer to firms at the technological frontier of EV battery production. Thus, we consider it an open empirical question as to whether and what degree CEE governments' industrial policy strategies can help local firms to learn from South Korean and Chinese EV battery firms and leverage the emerging battery supply chains to indigenize foreign knowledge.

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