Agora Verkehrswende

DISCUSSION PAPER

A strong European battery industry for a strong automotive sector

Nine insights for expanding battery production for electric mobility in Germany and Europe

Imprint

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Foreword

Dear readers,

Historic changes are underway in the automotive industry. Beyond transforming drivetrain technology, the transition to electric mobility is reshaping the industry. A key technology and strategic asset in a complex and competitive international market that lies at the core of these changes is the battery.

Today, Asian manufacturers currently are market and technology leaders in battery production. China has outpaced other countries at all stages of the value chain, from securing raw materials and processing to mechanical engineering for cell production and recycling. This lead has become cemented by delays and even cancellations of construction projects for battery (cell) factories in Germany. At the same time, the effects of new US customs policies under Donald Trump's second presidency show how quickly conditions in international trade can change. The European and German battery industries currently being established must prove themselves in this environment.

European decision-makers have recognised the need for action. Recently published EU-proposals in both the Clean Industrial Deal and the Automotive Action Plan aim to build a more independent and resilient battery value chain. The new German government has also set itself the task of establishing battery cell production in Germany. But how can local production become more competitive and crisis-proof in ways that strengthen the domestic automotive industry?

This position paper outlines steps towards a sustainable battery industry in Europe and in Germany. In nine insights, we lay out the domestic industrial conditions, global dynamics and current challenges with respect to establishing a domestic battery industry – and present potential solutions. We also discuss the EU's plans and make recommendations for a more robust battery value chain in Europe. In this regard, we at Agora Verkehrswende emphasise the critical importance of new forms of cooperation. Europe and Germany must work together with technology leaders and raw material-producing countries while also expanding their own expertise and production capacities. This is the way to achieve a resilient battery industry in Europe.

It is now up to politicians and industry to shape this path. We hope this publication provides impetus for the necessary decisions.

We hope you find this publication stimulating and look forward to furthering the conversation.

Christian Hochfeld
on behalf of the Agora Verkehrswende team
Berlin, June 2025

Contents

1 | Batteries are the key technology for the successful transformation of the automotive industry

The rapidly growing global demand for batteries, accompanied by significant price fluctuations, is hitting a European battery industry in a crucial phase of its development. Now is the time to set the course for the battery industry in Germany and Europe.

1.1 Global demand for batteries will multiply

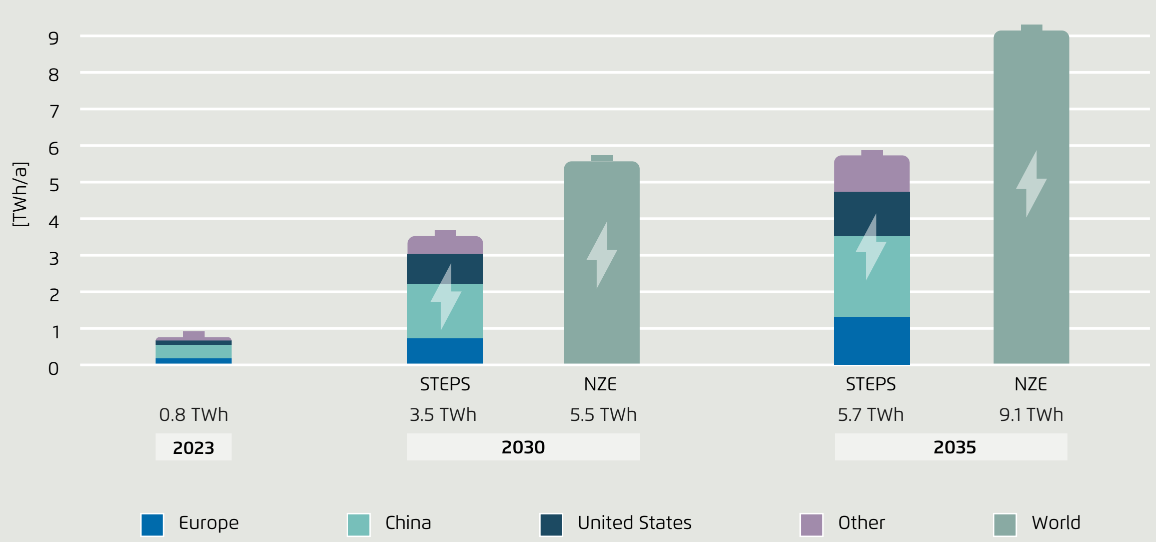
The transformation of the automotive industry towards electric mobility will be accompanied by immense growth in battery sales. Based on an analysis of policies already been adopted and currently in planning (the Stated Policies Scenario, or STEPS for short), the International Energy Agency (IEA) has concluded that global demand for batteries for electric vehicles will increase more than fourfold by 2030 and approximately sevenfold by 2035.[1] At 800 GWh in 2023, global demand could reach 3,500 GWh (3.5 TWh) by 2030 and 5,700 GWh (5.7 TWh) by 2035 (see Figure 1). As expected, the largest share of battery demand will come from the passenger car sector (around 75 percent in 2035). This will also lead to large regional differences in battery capacity demand. Especially in regions where motorised two- and three-wheelers make up a large part of the vehicle fleet, demand is significantly lower than in markets where passenger cars dominate, as two- and three-wheelers require much smaller batteries. This is particularly the case in emerging or developing economies. In the STEPS scenario, the People's Republic of China (hereinafter referred to as "China") (2.2 TWh), the European Union (hereinafter referred to as "Europe") (1.3 TWh) and the USA (1.2 TWh) account for by far the largest share of battery demand, while the rest of the world accounts for 1 TWh.

The current global distribution of new electric vehicle purchases is similar. Here, too, China, Europe and the USA account for by far the largest share of sales.[2] It is worth noting here that achieving the IEA's net-zero emissions scenario (NZE) for 2050 would require far greater capacity through more profound electrification of the transport sector. The net-zero emissions scenario is the only IEA scenario in which global greenhouse gas emissions remain below the 1.5 degree mark agreed on

1 IEA (2024a).

2 IEA (2024a).

Battery demand for electric vehicles: Europe ranks second according to scenarios — Figure 1



Agora Verkehrswende (2025) | STEPS = Stated Policies Scenario of the IEA, NZE = Net Zero Emissions Scenario of the IEA; for the NZE scenario, there is no breakdown by world region. Source: IEA (2024a).

in Paris. Under this scenario, the battery demand would already reach 5.5 TWh in 2030 and 9.1 TWh in 2035, increases of approximately seven to eleven times the 2023 baseline.

However, the IEA does not foresee bottlenecks in this regard. If the current announcements for battery production by investors and companies are implemented as planned, global production capacity could already exceed 9 TWh by 2030. Assuming 85 percent utilisation of these plants, this would correspond to a real production rate for EV batteries of around 8 TWh, of which 5.5 TWh of production capacity or its expansion has already been confirmed as operational today. On this basis, the NZE requirements for 2030 could be met, and a seemingly feasible increase in production capacity of 1.1 TWh would be necessary for 2035.

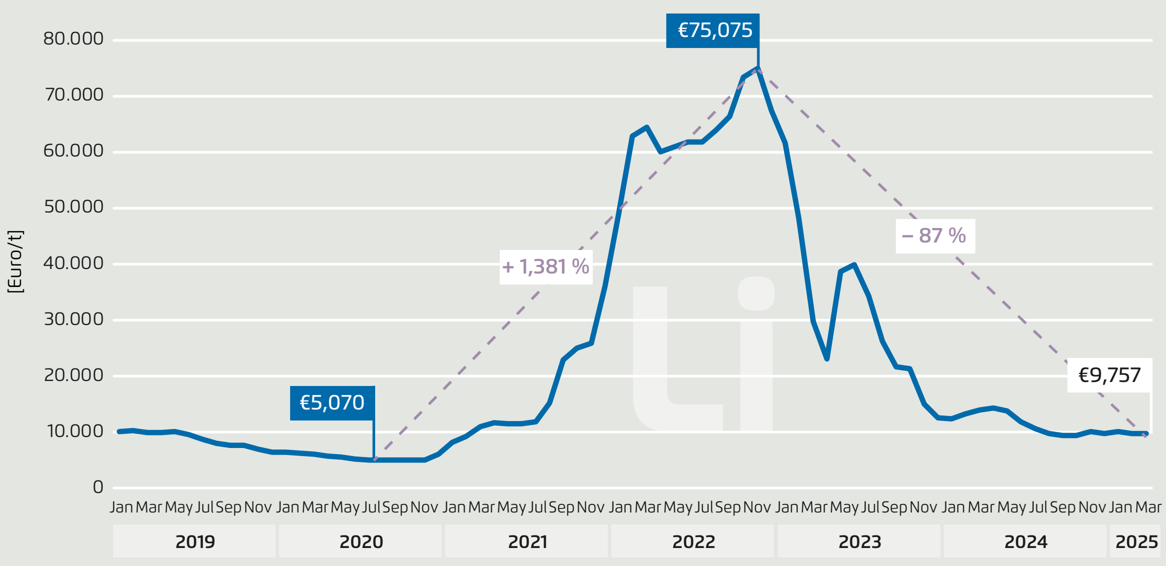
However, such high utilisation of battery production facilities can only be considered theoretical and depends, among other things, on achievable prices, which in turn depend on real demand. To cite one example, capacity utilisation at Chinese plants fell from an average of 51 percent to 43 percent in 2023 due to overcapacity resulting from recent weak EV demand.[3] This, in turn, may have an impact on the speed of the ramp-up.

1.2 The battery ramp-up is unfolding against a backdrop of large price fluctuations and high price pressure

Price fluctuations for batteries are closely linked to raw material prices, among other factors. According to an analysis by M-Five, batteries[4] account for 30 to 40 percent of the production costs of an electric car.[5] A closer look at the cost structure reveals that the battery cell accounts for by far the largest share (up to 75 percent).

3 McKerracher (2024).
4 A lithium-ion battery in electric vehicles consists of battery cells that store energy, modules that bundle several cells, and the battery pack, which integrates the modules with cooling and a battery management system (BMS, for monitoring and controlling the battery) (see also insight 4).
5 Schade, Haug, Berthold (2022).

Fluctuating raw material prices hamper battery cell production — Figure 2



Agora Verkehrswende (2025) | Source: Trading Economics (2024).

The battery cell can be divided into the cathode, the anode and the separator. Around 65 percent of production costs are attributable to material costs, which are heavily influenced by the prices of the underlying raw materials.

Raw material prices therefore have an impact on the cost development of batteries and thus on the ramp-up of electric mobility. Most recently, the raw material prices for lithium, which is crucial for electric car batteries, fell sharply after a steep rise between 2021 and 2022 (see Figure 2). In recent years, many companies have expanded their lithium production capacities to meet growing demand. New mines have started operations in countries including Australia, Chile and Argentina. This has led to an oversupply of lithium at a time of weak demand for electric vehicles and resulted in declining lithium prices. As a result, prices for lithium-ion batteries have also fallen.[6] This creates a dilemma: new lithium mining projects will only get off the ground if prices are high enough and investments are profitable. It takes years to develop new mines. If demand for batteries and electric vehicles rises again in the future, as projected, shortages could arise despite the current oversupply of lithium, driving up prices for lithium as well as batteries and electric cars.

According to Bloomberg, however, the decline in prices for lithium-ion batteries is based on two other factors in addition to raw material prices: China's overproduction of batteries, which already exceeds demand, and tight margins for manufacturers, which result in cost reductions and the need to optimise production processes to stay competitive. These developments are reinforced by increasing efficiency gains in production and the scaling of production capacities, which is further accelerating the overall price decline. Bloomberg currently predicts that prices for batteries will remain low for the next few years, particularly in China, due to current overcapacity (higher battery production than demand for electric vehicles).[7] In April 2024, the price of low-cost lithium iron phosphate batteries in China was 75.3 US dollars per kilowatt hour, which, according to the report, means that electric vehicles in the country could already be offered at the same price or below the market price of combustion engine alternatives. Favourable market prices could have a positive impact on future demand for electric vehicles both in China and including internationally, but they put potential European battery manufacturers under considerable price pressure.

1.3 The European battery industry is in a critical phase

In 2017, the European Commission launched the European Battery Alliance, a multi-stakeholder coalition of players in the battery supply chain and the European Investment Bank (EIB). In 2018, it also adopted a strategic action plan for batteries. This set out the ambitious goal of making Europe a world leader in sustainable battery production and use in a circular economy framework.[8] This is a strategically important goal that would reduce the EU's dependence on imports, strengthen the value chain within Europe and create or transfer new jobs, as discussed in more detail in the following insights.

In recent years, major capacity increases in gigafactories and related industrial facilities have been announced in Europe (see Figure 6 in insight 4). The geographical concentration of the announced battery cell production facilities in the EU is interesting. Many investments are concentrated in Hungary, France and Spain, followed by Germany. Proximity to major automotive centres enables efficient logistics, just-in-time deliveries and close cooperation between automotive manufacturers, battery producers and other suppliers. These synergies are crucial for driving technological development and reducing costs.

Nevertheless, there is a considerable gap between ambition and reality in European battery production. In 2025, Europe is far from a world leader in sustainable battery production. There is considerable uncertainty today regarding announced and established battery cell production sites in Europe and Germany.[9] Europe is competing with other world regions that offer generous subsidy schemes. Practical difficulties in scaling up production coupled with price pressure and a climate of uncertainty regarding demand for electric vehicles

6 McKerracher (2024).
7 McKerracher (2024).
8 European Commission (2018).
9 Demling et al. (2024).

in Germany and Europe in the coming years make this a critical moment for the entire European value chain. Europe has high ambitions for building a battery industry. But actual progress faces huge challenges in a global market environment characterised by price fluctuations, price pressure and the technology and production lead in China.

2 | Asia is the technology leader for batteries

Global sales of electric vehicles, as mentioned above, are currently concentrated in a few markets: China, Europe and the USA. China is clearly in the lead, accounting for more than half of all new electric vehicle registrations (almost 60 percent of new electric vehicle registrations worldwide) in 2023.[10]

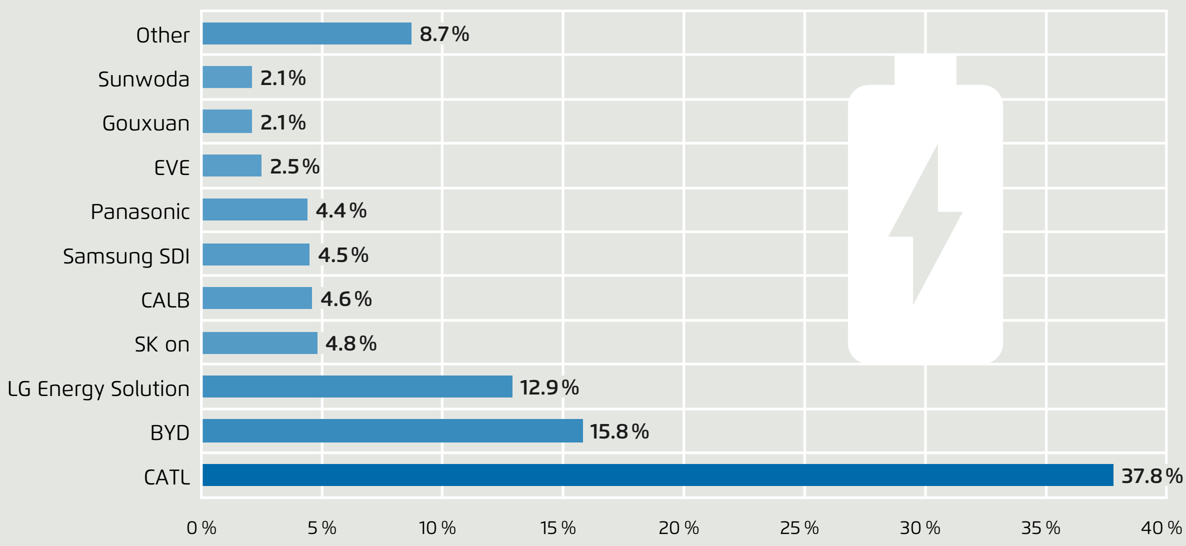
2.1 The world's leading cell manufacturers are in China, South Korea and Japan

China, South Korea and Japan occupy a dominant position in both EV sales and in battery technology itself. This is underlined by their global market shares in cell production. In the first half of 2024, all leading cell manufacturers came from China, South Korea or Japan, and the situation was similar in 2023 and 2022.[11] Battery cell production in Germany amounted to just 0.88 GWh in 2022, accounting for 0.2 percent of global production, while cathode production accounted for 4 percent of global sales.[12] With regard to Europe, the European Economic and Social Committee stated: "Europe is lagging alarmingly behind Asian countries and companies in the development (R&D) and production of batteries."[13] Even while organisations like the Fraunhofer ISI come to a less pessimistic conclusion in its international comparison of scientific publications and publications, China and Japan still have a significant lead.[14]

Figure 3 shows that Chinese cell manufacturer CATL is the global leader with a global market share of nearly 38 percent. In second place with a market share of just under 16 percent is Chinese battery manufacturer BYD, which also produces electric cars under the same brand name. South Korean manufacturer LG Energy Solutions, which achieved a global market share of just under 13 percent in the first half of 2024, stands in third place. The ranking shown here underscores how far manufacturers from China, South Korea and Japan have expanded their market position and how strong their

10 IEA (2024a).
11 SNE Research (2023), (2024); Kang (2024).
12 Fraunhofer ISI (2024).
13 EESC (2019).
14 Fraunhofer ISI (2024).

Asian companies are the leading battery manufacturers on the global market — Figure 3



Agora Verkehrswende (2025) | Data refers to the first half of 2024. Source: SNE Research (2024).

lead is compared to German or even European manufacturers, which are not mentioned separately in this figure.

2.2 European mechanical and plant engineering has a chicken-and-egg problem

The leading position of Asian manufacturers is particularly evident in mechanical engineering. While Germany and Europe are generally well positioned in mechanical and plant engineering, the expertise in production technology for the battery industry lies in Asia. The National Platform Future of Mobility noted in 2019 that research and development must focus on scaling battery cell production from the laboratory to industrial scale.[15] This is still true in 2025. In scientific research on battery cell production matters are stated diplomatically: "So far, compared to its Asian competitors, European mechanical and plant engineering has only been able to establish itself to a limited extent as a supplier to the battery industry emerging in Europe."[16] There is a lack of experience in the manufacture of turnkey, ready-to-use plants for the battery industry. This is a chicken-and-egg problem that is not easy to overcome. German and European mechanical engineering must prove their reliability. The battery production process involves many technical challenges, particularly with respect to the electrode coating and drying that is crucial for cell quality.[17]

It is important for the newly emerging European cell manufacturers to present themselves as trustworthy industrial partners. In 2024, BMW announced that it was ending its collaboration with Northvolt due to major delays in the schedule and excessive scrap rates.[18] Although the equipment used by Northvolt itself came from China,[19] the example illustrates that the smooth ramp-up of industrial series production is key for European cell manufacturers. It is likely to be difficult to convince industry partners to rely on equipment manufacturers without proven production experience.

15 NPM (2019).
16 VDI/VDE-IT (2024).
17 Fraunhofer FFB (2024).
18 dpa (2024).
19 Freitag, Hucko (2024).

New market players face many challenges. Plants require large capital investments and competition for skilled workers is global. The European Battery Alliance states: "Europe lacks key human capital skills, particularly in the field of applied process design."[20] The shortage of skilled workers in battery cell production in Europe is estimated at around 100,000 skilled workers for 2030.[21] This is also a kind of chicken-and-egg problem because without skilled workers, it is difficult to develop innovations or open new locations, and without innovative strength and new locations, skilled workers will not come to stay. Both the EU Commission and the German federal government are aware of the problem and have established training programmes in the batteries field.[22] The European Commission predicts that the problem will persist in transformative technology fields in the coming years.[23]

2.3 Asia will remain the technology leader for the foreseeable future

Considering the relative strengths and weaknesses of various players and markets, the question arises as to how the balance of power will develop in the future. Fraunhofer ISI points out that many Chinese battery manufacturers have not only already achieved a leading market position, but are also expanding further through additional investments in production capacity and technology. The authors conclude that this gives Chinese players a significant competitive advantage over their global competitors.[24] Bloomberg New Energy Finance comes to similar conclusions: "Through solid, long-term planning and support, China has gained a significant lead in batteries and the electric vehicle supply chain."[25]

Economic clusters have grown over time and are the result of political decisions and economic conditions. Their design can also be influenced by political and economic conditions, so in principle they can be established in new places as a consequence of political decisions.

20 European Battery Alliance (n.d.).
21 Fraunhofer FFB (2024).
22 See, for example, QualiBatt BW (2022); EIT InnoEnergy (2023); EIT (2024); albatts (n.d.).
23 European Commission (2023a).
24 Fraunhofer ISI (2024).
25 BloombergNEF (2024).

However, given the strong position of China, South Korea and Japan and the challenges facing European industry, it can be assumed that Asian manufacturers will remain technology leaders for the foreseeable future. Production scaling in Europe will require a solution to the broader skilled labour problem, and it will also be necessary to recruit internationally experienced specialists who have already accompanied scaling processes for similar plants in other world markets.

3 | As a strong automotive location, Germany needs a strong battery industry in Europe

The automotive industry in Germany and Europe is facing irreversible structural change, with electric mobility becoming the dominant form of transportation. Batteries are a key technology in this transformative process and crucial for the competitiveness of the German automotive industry. It is important to establish a resilient, sustainable and globally competitive battery industry in Europe to become less dependent on international supply chains and market dynamics in the long term.

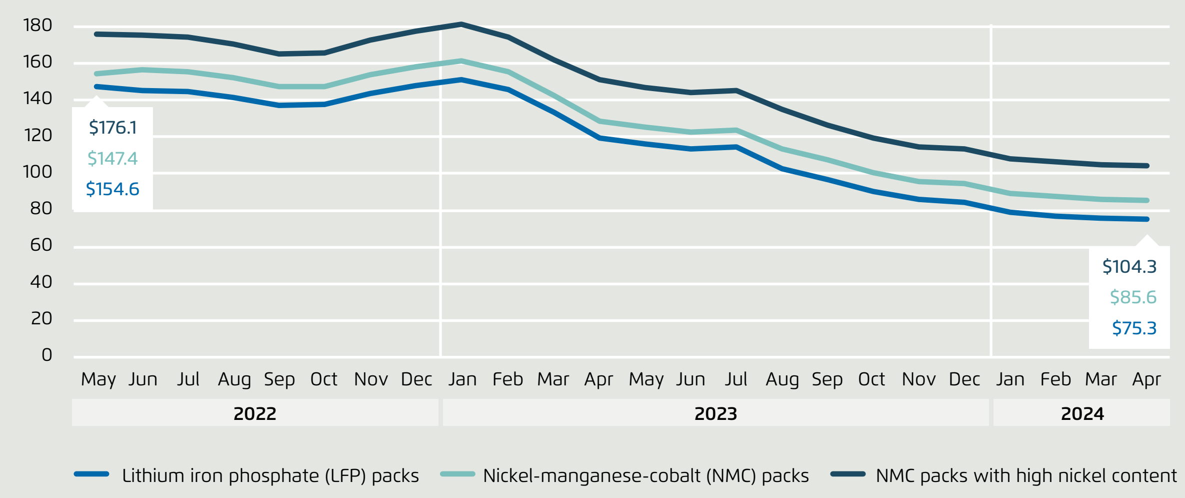
3.1 The global trend towards electric mobility is set

While electric vehicle sales in Germany fell short of expectations in 2024, the switch to electric powertrains is a long-term global trend, as the transformation to a climate-neutral economy will continue in all industrial sectors. The major automotive markets of China and the USA have introduced strong incentives for electric car sales and industrial development in recent years. This has led to a further decline in battery prices worldwide (see insight 1.2).

IEA projections show that markets in China, the US and Europe will have the greatest influence on electric car sales figures. According to the IEA's STEPS scenario described above, based on the political targets agreed to date, every second car sold worldwide will have an electric drive by 2035.[26] In the Net Zero Scenario (NZE), which is aligned with climate targets, the share of electric cars in 2035 is 98 percent. In Germany and Europe, the CO_2 Passenger Car Regulation ((EU) 2023/851) establishes the legal framework. With the requirement for car manufacturers to reduce the specific emissions of their new car fleet to zero grams of CO_2 per kilometre from 2035, electric vehicles will account for a much larger share of the total fleet in the future. In Germany, there was a significant increase in new registrations of electric vehicles in January 2025; it went up 54 percent from the previous year.[27] This is most likely due to a new CO_2 regulation limit for passenger cars that will come into force in 2025, requiring higher shares of electric vehicles. The ongoing decline in battery prices is another key factor (see Figure 4) in the long-term global success of electric mobility.

26 IEA (2024a).
27 ICCT, IMT-IDDRI, ECCO Think Tank (2025).

Already below $100/kWh: China's low-cost battery packs are driving the ramp-up of electric mobility — Figure 4



Agora Verkehrswende (2025) | NMC= Nickel-manganese-cobalt and includes prices for NMC111, NMC532 and NMC 622 batteries. High-nickel NMC includes NMC811, NMC955 and NCA. Source: BloombergNEF (2024).

While the debate about EU limits keeps flaring up in Germany, the long-term global trend towards electric mobility is set. It is important for Germany to become a leader in electric mobility. This requires defining and supporting structural change in the automotive industry.

3.2 The battery is the key technology for German automotive industry competitiveness

The German automotive industry is crucial to the German economy, contributing some 4.4 percent to German gross value added and employing 740,000 people.[28] Multiple drivers are at play in the industry's current transformation. In addition to the electrification of the powertrain, autonomous and connected driving plays an important role, as does the trend towards further productivity increases as part of the fourth industrial revolution (Industry 4.0). Changes in productivity affect jobs. A study by Agora Verkehrswende in collaboration with Boston Consulting Group shows that while the transformation will have only a minor impact on the total number of jobs, there will be major shifts. Although a decline in the number of employees in the core automotive industry is expected by 2030, this loss can be largely offset by rising demand for labour in powertrain-independent supplier companies. The study highlights the important role of the battery industry: "Around 95,000 jobs will be created by powertrain-independent suppliers alone, primarily by battery manufacturers – provided that German demand for battery cells is met by domestic production."[29] The successful establishment of the battery industry is therefore of great importance for jobs in Germany. According to the study, job growth is expected primarily in eastern Germany.

In addition, a domestic battery industry is also relevant from a technological and innovation policy perspective. An actor that wants to be a leader in electric mobility must also be a leader in battery technology, as a large part of the value added is attributable to the battery.[30] Strong in-house expertise in the battery value chain is a prerequisite for competitiveness and innovation in Germany and the EU.[31] The ambition to play an important role in battery cell production and battery technology as a whole is justified given the importance of the automotive industry and the challenges posed by the transformation of the industry. But this is an ambitious goal in view of the current competitive position of the industry in Germany and Europe . The last German government's target of having 15 million purely electric vehicles on the road by 2030 also underlines Germany's ambition to become the leading market in this field.[32] However, the signs are currently pointing in a different direction. Without intervention, the target will be missed by up to six million electric cars.[33]

3.3 Resilience, competitiveness and sustainability are key pillars for building a battery industry in Germany and Europe

Russia's war of aggression against Ukraine highlighted our dependence on fossil fuels and brought the supply and value chain security issues to the forefront of public debate. Questions regarding automotive industry transformation towards electric mobility must be considered together with matters of resilience. Resilience can be understood as the ability to "withstand external shocks or disruptions to social, economic or political conditions, particularly with regard to international integration, and to adapt to the new conditions".[34] Batteries already store most domestically produced electricity, which powers cars and balances fluctuations in a renewable electricity grid. The need for this form of storage will continue to increase as the energy transition progresses. Unlike fossil fuels, which must be continuously imported and where supply chain disruptions can lead to energy price increases, batteries help strengthen resilience. Once imported or manufactured in Europe, they can be reused for many years. Building resilient supply chains and domestic manufacturing capacity for batteries is therefore of great public interest for securing prosperity in the long term. Due to the strong international dimension

28 Agora Verkehrswende (2024).
29 Agora Verkehrswende (2021).
30 Agora Verkehrswende (2024).
31 BMWi (2018); European Commission (2018).
32 SPD, The Greens, FDP (2021).
33 Agora Verkehrswende (2024).
34 Prognos, Öko-Institut, Wuppertal Institute (2023).

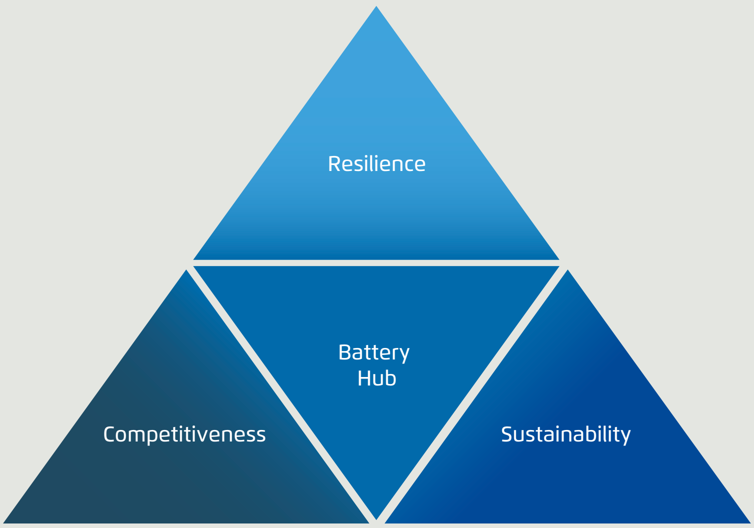
of these issues, it is necessary to consider Germany and Europe from the outset.

Since formulating its first European battery strategies, the European Union has emphasised sustainability. Battery cells manufactured in Europe should also be advantageous in terms of sustainability. The EU Battery Regulation was written to regulate battery carbon footprints. EU authorities aim to further reduce this footprint to improve the overall environmental performance of electric vehicles. Requirements have also been established for due diligence in supply chains, including regarding human rights violations, and far-reaching recycling requirements have been adopted that have the potential to stimulate a circular economy in the field of electric vehicle batteries (see insight 8).

Strategies for a strong battery industry in Germany and Europe should address three dimensions: resilience, competitiveness and sustainability with respect to climate, environmental and human rights. Resilience covers topics such as how to minimise the use of primary raw materials (for example, with modified battery technologies or recycling), how to achieve greater participation in international value chains, and strategic partnerships with countries within international value chains (see insights 3, 6, 7 and 8). Competitiveness includes topics such as the need for international cooperation and research funding (see insights 4 and 5). Sustainability involves battery recycling, the use of secondary materials, further reduction of the carbon footprint and ensuring responsibility in the supply chain with regard to compliance with human rights and environmental standards (see insight 7).

Many analyses within this topic area deal with one or two of these dimensions (resilience, competitiveness, sustainability). This paper structures a discussion based on all three dimensions. Ultimately, the European Union must strive to be competitive in the field of cell production and battery manufacturing, to produce batteries with high sustainability standards and, at the same time, to better safeguard Europe's resilience in terms of security of supply. That said, it is not necessarily feasible to make improvements in these three areas at the same time or to the same extent. The question of where to focus must be decided through political negotiation.

Target triangle for the development of Germany as a battery hub in Europe — Figure 5



Agora Verkehrswende (2025) | Own depiction.

4 | European industry is dependent on cooperation with Asian manufacturers

The goal of establishing Europe as a battery production site based on the triad of competitiveness, resilience and sustainability is ambitious. It is probably impossible for the German battery industry to catch up with Asian manufacturers on its own, not least given the technological leadership of Asian suppliers. Close cooperation is therefore crucial. This includes cooperation between different players in the German or European supply chain, a current topic of investigation in German battery industry research.[35] It also includes cooperation between German players and companies from China, South Korea and Japan.

4.1 Global competition for technology hubs is in full swing

In general, the governments of all major electric vehicle markets are interested in a strong domestic value chain. The best-known example of localisation is the Inflation Reduction Act (IRA) passed in 2022, in which the US incentivises the sale of electric vehicles and establishes extensive financial support for the battery industry in its own country with the aim of reducing the difference in production costs compared to its lower-cost competitor, China.[36] This support is provided through tax breaks and related conditions including the use of locally manufactured components (local content requirements).

The European Union has enacted a legal regulation framework comprising the Battery Regulation, the Net Zero Industry Regulation (NZIA) and the Critical Raw Materials Regulation, which together are intended to lead to significant localisation by 2030. This is supplemented by additional strategies including the Clean Industrial Deal and the Automotive Action Plan (see insight 9). But the European approach suffers from far greater complexity, not least due to greater fragmentation of financial support instruments. Furthermore, the Draghi Report states that financing opportunities in Europe are five to ten times lower than those offered by the American programme. The introduction of the IRA has intensified competition for future technologies for transformation, even if its continuation under the new administration is still open.[37]

35 VDI/VDE-IT (2023b).
36 Draghi (2024).
37 Prognos, Öko-Institut, Wuppertal Institute (2023).

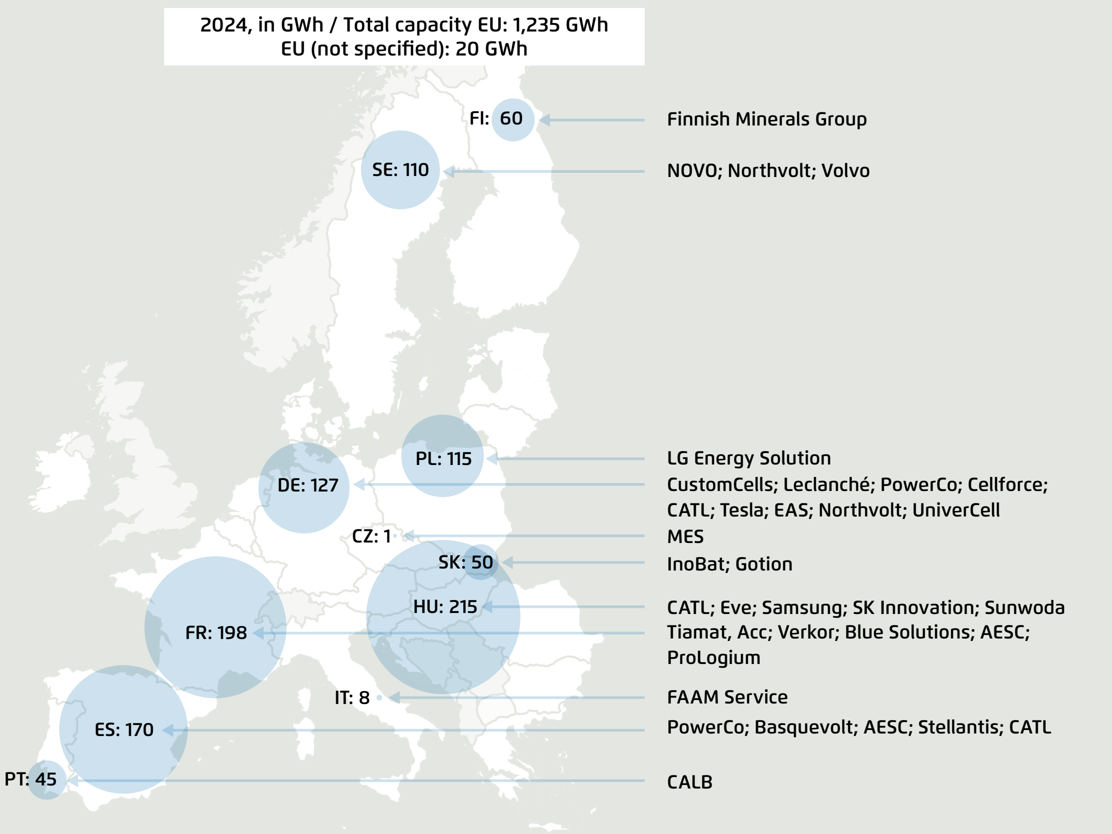
Given extensive investment subsidies in the USA and Canada, cell manufacturers from Europe have also announced plans to invest in the US. The cell production capacities announced in North America now exceed one terawatt hour, reaching the same level as those announced in Europe.[38] Announcements regarding cell production capacities are subject to frequent change. More recent estimates consider cell production capacities of 740 gigawatt hours to be more realistic for Europe in 2030.[39] Nevertheless, Europe is currently and will remain the world's second-largest market for electric vehicles. Accordingly, in addition to investments in North America, companies are also pushing ahead to establish cell and component production in Europe (see Figure 6).

Within Europe, Hungary, France and Spain are the leading countries in terms of location announcements for battery cell production, with Germany in fifth place behind the United Kingdom.[40] This represents a significant shift from earlier announcements. In 2022, Germany was still in first place in terms of planned cell production capacity, which at that time amounted to just over 490 gigawatt hours.[41] The IEA notes a general trend towards battery production being located close to battery demand.[42] This explains the investments in Europe. However, many projects are still at the announcement stage or in the early stages of development. The actual realisation of these projects will depend largely on supporting measures such as fast approval processes and financing options.[43] The significant decline in announcements in Germany, coupled with increases in other European countries, reflects a sharp decline in optimism regarding Germany as a place for e-mobility investment and development in recent years.

38 Prognos, Öko-Institut, Wuppertal Institute (2023); VDI/VDE-IT (2023a).
39 PEM RWTH Aachen, Roland Berger (2025).
40 Battery News (2024).
41 PEM of RWTH Aachen, VDMA (2022).
42 IEA (2024a).
43 Draghi (2024).

Battery cell production in Europe: Hungary leads the way

Figure 6



Agora Verkehrswende (2025) | Data as of December 2024. The battery cell production capacity shown per country includes both projects already implemented and announced projects. The information is not exhaustive. Source: battery-news.com (2024).

4.2 European vehicle manufacturers are already cooperating with Asian manufacturers to benefit from their expertise

In China, the automotive industry has many years of experience with corporate partnerships (known as joint ventures). Since the 1980s, Chinese economic policy has promoted joint ventures between international automotive manufacturers and Chinese companies.[44] The automotive market in China is highly competitive and characterised by consolidation and price competition, particularly in the electric passenger car segment.[45] In this competitive environment, VW announced its cooperation with Chinese electric car manufacturer Xpeng in July 2024. The goal is to equip all electric vehicles on the Chinese market with a jointly developed electronic architecture.[46] This example shows that global automotive companies are leveraging the technological advantages of Chinese companies – for example, in digitalisation – through joint ventures and cooperation agreements. This type of cooperation is sometimes referred to as a reverse joint venture.

44 Xue, Wei, Greeven (2024).

45 IEA (2024a).

46 Fiedler (2024).

A trend towards joint ventures is also evident in the European market. In October 2023, Stellantis entered into a joint venture with Chinese car manufacturer Leapmotor. The aim is to sell affordable electric vehicles for less than 25,000 euros in Europe.[47] According to media reports, the joint venture between Stellantis and Leapmotor also plans to produce in Poland. BYD wants to build electric cars in Hungary, and other European sites for joint ventures and foreign direct investment are under discussion.[48] In a similar vein, Stellantis recently announced a cooperation with CATL to produce batteries in Europe.[49] But it is unclear to what extent the European participants will be able to benefit from the technological knowledge of their Chinese partners.

Analysts note that Chinese battery manufacturers appear to be looking to establish part of their value chain, such as cathode or anode manufacturers, in Europe as well.[50] For example, the Finnish Minerals Group announced a cooperation with Beijing Easpring Material Technology for the production of cathode materials in southern Finland.[51] The process of localising Chinese manufacturers in Europe has thus already begun. However, EU member states are competing amongst themselves to offer the best conditions for foreign direct investment. According to an analysis by the Rhodium Group, Hungary has been particularly successful in this regard, attracting 53 percent of Chinese investment in Europe in 2022 and 2023.[52] To avoid distortions of competition in the European single market, Europe needs common rules for foreign direct investment (see insight 9).

4.3 Europe needs more battery joint ventures

Localisation policy aims at greater European sovereignty in the face of complex and unstable global supply chains. The goal is to strengthen resilience in the event of supply chain disruptions and create high-quality jobs in Europe, that is, jobs that offer fair pay and development prospects. But the innovation potential resulting from such localisation projects is no less important. Joint ventures in Europe offer European manufacturers the opportunity to gain knowledge. The establishment of these technology leaders in joint ventures with German or European partners can create potential for further innovation – either for solutions tailored to the European ecosystem or for global development. Joint ventures offer an opportunity to overcome the chicken-and-egg problem (see insight 2.2) in the mechanical engineering sector, for example, cell manufacturers and their suppliers could learn from the market leaders in Asia.

Innovation potential is crucial if the EU wants to stimulate battery production in Europe that is both sustainable and competitive. But it is precisely on this point that the Draghi Report states that although half of the announced investments in the battery industry come from non-EU companies, in most cases these are not in the form of joint ventures.[53] The economic area is thus currently missing out on an opportunity for technology transfer. This makes it all the more interesting that the possibility of joint ventures in the battery sector was announced in the Automotive Action Plan (see insight 9). In sum, both greater localisation of Asian technology leaders and increased cooperation in joint ventures are key to the competitiveness of Europe as a battery development and production site. Without such cooperation, it will not be possible to catch up with Asian manufacturers. Europe needs attractive investment conditions, and the EU Commission must play a coordinating role (see insight 9).

47 Knauer (2024).
48 Reuters (2024a).
49 Moss algae (2023).
50 Sebastian, Goujon, Meyer (2024).
51 Hampel (2023).
52 Sebastian, Goujon, Meyer (2024).
53 Draghi (2024).

5 | When optimising vehicle batteries, increasing energy density and reducing costs are key priorities

Extensive research into the technological advancement of electric vehicle batteries is underway. After all, improving battery properties is a crucial area of competition (see previous insight). Lithium-ion batteries are currently the dominant battery technology for passenger cars. There are different types of lithium-ion batteries and a variety of other chemical compositions for vehicle and industrial batteries. A battery cell generally consists of anodes and cathodes and a separator that separates the electrodes from each other. Between them is the electrolyte required for charge transport (see Figure 7).[54]

In Europe, battery types with cathode material mixtures of nickel, cobalt and aluminium (NCA) or nickel, manganese and cobalt (NMC) have been predominantly used to date, with lithium iron phosphate (LFP) cathode compositions also becoming increasingly common in recent years.[55] Due to different mixing ratios of nickel, manganese and cobalt, the proportion or type of raw materials required for their production varies. To further increase the performance of NMC cathodes and reduce dependence on cobalt, the cobalt content of NMC cathodes has been reduced and the nickel content increased.[56] LFP batteries do not require cobalt or nickel, while alternative battery technologies such as sodium-ion batteries (SIB) do not require lithium and, in some cases, nickel or cobalt. The alternative battery types are at different stages of research and development, with some close to market maturity and others still a long way off.[57]

A vehicle battery must meet many requirements. The type and size of the battery influence the price, range and charging time of an electric vehicle. In addition to safety, the following aspects are particularly important: energy and power density, service life and cost (see Figure 8). Higher energy density means greater range, while power density determines acceleration. The service life can be specified as cycle life or calendar life, both of which are parameters for battery ageing.[58] The service life of the traction battery is decisive for the overall usability of the electric vehicle. Other relevant parameters include fast-charging capability, reparability, CO_2 footprint and the corresponding raw material requirements.

As battery development moves forward, the most important factors are currently cost reduction and increasing energy density (i.e., range).[59] This is shown in Figure 8 as an ideal case. Higher energy density makes it possible to achieve a certain range with lower battery weight and thus also with lower material consumption.[60] Although all battery properties can be improved, it is not possible to optimise all parameters at the same time.

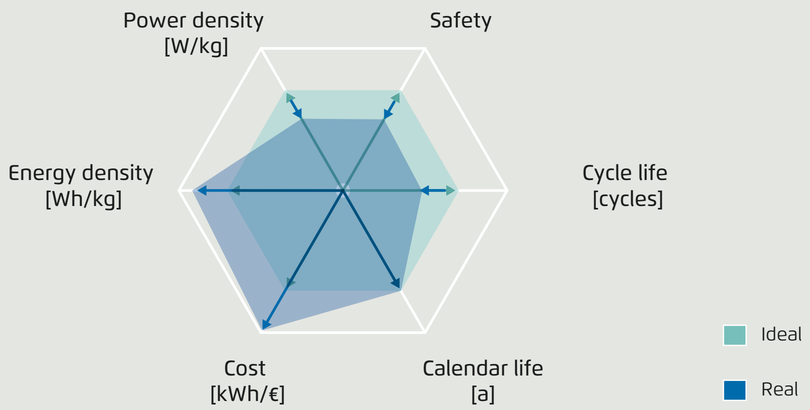
54 PEM RWTH Aachen, BLB TU Braunschweig, VDMA (2021).
55 Agora Verkehrswende (2021); IEA (2024a).
56 Agora Verkehrswende (2021).
57 Fraunhofer ISI (2023a).
58 Battery Forum Germany (n.d.).
59 Sauer (2023).
60 ifeu (2019).

Schematic representation of the structure of a lithium-ion battery cell — Figure 7

Agora Verkehrswende and Fraunhofer ISI (2025) | Own depiction based on Fraunhofer-Allianz Batterien (2017).

Schematic representation of trends in the further development of electric car battery performance parameters

Figure 8



Agora Verkehrswende (2025) | Own depiction based on Sauer (2023).

The figure therefore distinguishes between "ideal" (all battery properties improve simultaneously) and "real" (certain battery properties improve, others do not). Improving individual aspects goes hand in hand with compromises in other areas. For example, increasing the energy density of the battery often reduces its cycle lifetime. Vehicle battery developers need to optimise the properties of future battery generations so that they meet customers' needs as effectively as possible while complying with all safety and regulatory requirements and at the lowest possible cost.

5.1 The market share of LFP batteries has grown significantly and will continue to rise

The sharp rise in the global share of LFP cathode compositions (see Figure 9) is a notable recent development. In recent years, the share of LFP has increased significantly to over 40 percent worldwide, more than double the share in 2020.[61] In 2024, LFP batteries were installed in around two-thirds of all new electric cars sold in China.[62] The global market growth in this domain is therefore attributable to China. Even though the share of LFP batteries in new car sales in Europe was still at ten percent in 2024, the rapid growth of the LFP share in China shows that the dominant battery chemistry can change quickly – with implications for the global market for electric vehicles.

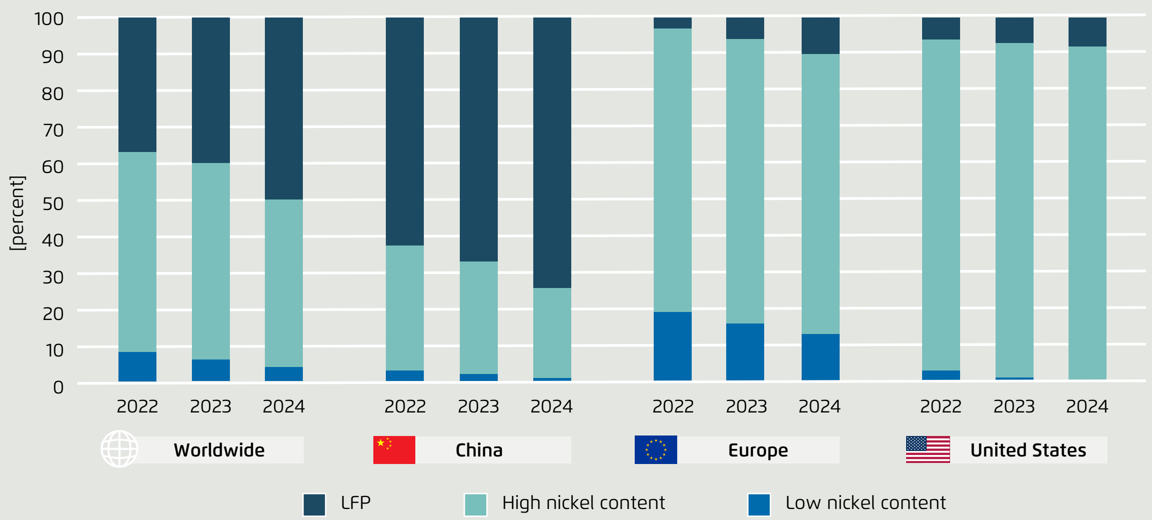
LFP batteries have lower energy densities than NMC batteries but, as mentioned above, they are cobalt-free and therefore significantly less dependent on critical raw materials.[63] They are also cheaper to produce.[64] For China, prices in 2024 are estimated at an average of 75.3 US dollars for LFP battery packs (see Figure 4 in insight 3.1).[65] It appears that the cost advantages of the LFP composition outweigh performance disadvantages. In addition, design methods (cell-to-pack cell design) can improve energy density shortcomings of LFP batteries can be improved.[66] Prices are expected to continue falling steadily. Lithium manganese iron phosphate (LMFP) cathode compositions are also mentioned in this context as a means of increasing energy density while keeping costs low.[67]

LFP and LMFP are likely to continue to account for a large share of the market in the coming years. Analysts

61 IEA (2024a).
62 VDI/VDE-IT (2023b); IEA (2024a).
63 For a definition of critical raw materials, see insight 6.
64 IEA (2024a).
65 BloombergNEF (2024).
66 Reid (2023); IW Consult, EY (Ernst & Young) (2024).
67 Fraunhofer ISI (2023c).

LFP batteries have gained significant market share in recent years

Figure 9



Agora Verkehrswende (2025) | Europe is understood here in accordance with the IEA's geographically oriented definition and also includes non-EU countries such as Norway, Switzerland and the United Kingdom. Source: IEA (2025).

predict high L(M)FP shares, with forecasts ranging from 43 percent to over 45 percent in 2030.[68]

When talking about battery types beyond lithium-ion batteries, media reports often focus on sodium-ion and solid-state batteries. Sodium-ion batteries offer potential for both lower resource consumption and cost reductions.[69] When manufactured on a large scale, sodium-ion batteries could be significantly cheaper than conventional lithium-ion batteries.[70] They are suitable for applications such as compact urban electric vehicles and stationary power storage and can also be useful for two- and three-wheeled vehicles.[71] Due to the potential cost advantages of sodium-ion batteries on a large scale and their lower dependence on critical raw materials, a further increase in their share of the global market is conceivable.[72]

The German Federal Ministry of Education and Research's (BMBF) umbrella concept for batter research focuses not only on sodium-ion batteries but also on all-solid-state batteries (ASSB) as "promising technology variants".[73] ASSBs promise higher energy densities and better safety properties than lithium-ion batteries.[74] ASSBs score highly in terms of range, but they are also likely to be more expensive and require significantly more lithium, which in turn compromises resilience and sustainability (see insight 3).[75] It remains to be seen how much customers will be willing to pay. Manufacturers such as Toyota and Nissan, for example, are planning to launch the first vehicles with this battery technology in 2027 or 2028.[76]

68 Goldman Sachs (2024); PEM RWTH Aachen, Roland Berger (2025).
69 Fraunhofer ISI (2023a).
70 Fraunhofer ISI (2023a); Reid (2023); IEA (2024a).
71 IEA (2024a).
72 P3 Automotive (2023), p. 3; Sauer (2023); Goldman Sachs (2024).
73 BMBF (2023).
74 Schmaltz (2023).
75 The Economist (2023b).
76 Randall (2024).

5.2 Different battery chemistries serve to segment the market into low-cost entry-level and expensive high-performance vehicles

A segmentation of battery technologies is already emerging: cheaper LFP batteries for entry-level vehicles and more powerful but more expensive NMC or NCA batteries for the premium segment.[77] The simultaneous advancement of both LFP and sodium-ion batteries and solid-state batteries indicates that this segmentation into inexpensive entry-level and expensive high-performance models with correspondingly varying cell chemistry is also to be expected in the future.[78]

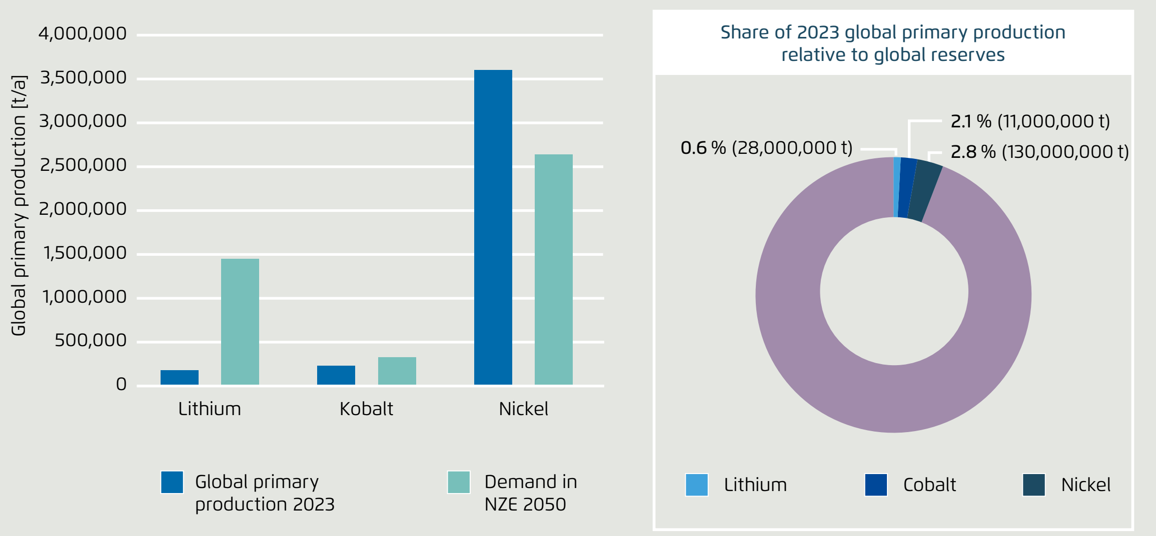
Ultimately, the battery strategies of all leading regions (USA, Europe, China, South Korea, Japan and also Germany) include a mix of lithium-ion batteries, sodium-ion batteries, solid-state batteries and other alternative battery technologies (for example, lithium-sulphur and others).[79] Although the focus of the individual strategies varies, all regions are avoiding committing themselves exclusively to a single technology in view of technological developments. While alternative battery technologies promise either cheaper and potentially more sustainable electric vehicles or even more powerful ones, the current prediction is that lithium-ion batteries will continue to be the dominant battery chemistry into the 2030s.[80]

5.3 Raw material requirements for vehicle batteries are shifting but also keep rising

The growing market for battery cells and electric vehicles requires an increase in the use of battery raw materials such as lithium, cobalt and nickel. Battery technology development is an important aspect in terms of minimising raw material requirements.

77 IW Consult, EY (Ernst & Young) (2024).
78 P3 Automotive (2023).
79 Fraunhofer ISI (2024).
80 Prognos, Öko-Institut, Wuppertal Institute (2023).

Global raw material demand for electric vehicle batteries will continue to rise — Figure 10



Agora Verkehrswende (2025) | Primary production figures for 2023 are estimates. "Reserves" refers to proven quantities of an energy resource deposit that can be extracted economically at current prices and using current technology. NZE = Net Zero Emissions 2050. Sources: IEA (2024a) and USGS (2024).

As mentioned above, the proportion of LFP in lithium-ion batteries will continue to increase significantly.[81] This will be accompanied by a substitution of critical raw materials. For example, with this shift, the demand for cobalt is likely to rise less sharply than would otherwise be the case.[82] But the rising demand for batteries as a whole means that a further increase in demand for cobalt is also to be expected.[83] Above all, this means that lithium is likely to remain a critical raw material, and that demand for nickel will also remain relevant (due to nickel-rich cathode compositions).[84] This is illustrated in Figure 10, which forecasts raw material demand in 2050 under a scenario of IEA net-zero emissions implementation and related increases in electric vehicle sales. Notably, reserves are not static. It can be assumed that further lithium reserves will be developed by 2050, and a such, reserves will not remain at 2023 levels until 2050. Although substitution effects due to technological change in batteries will occur, this will not reduce raw material demand in absolute terms – although the increase will be mitigated in the case of cobalt. It is therefore important to establish strategic partnerships with raw material-rich countries (see insight 6) and a functioning recycling industry in Europe (see insight 8), as well as further policy measures to reduce raw material demand, such as strategies for greater efficiency in passenger cars.

81 Goldman Sachs (2024); PEM RWTH Aachen, Roland Berger (2025).

82 IW Consult, EY (Ernst & Young) (2024).

83 McKinsey, Global Battery Alliance (2023).

84 McKinsey, Global Battery Alliance (2023); IW Consult, EY (Ernst & Young) (2024).

6 | Fair and strategic raw material partnerships strengthen Europe's resilience

Building a battery industry in the EU will depend on raw materials imports. As insight 5 shows, this mainly includes cobalt, lithium and nickel, but also copper, manganese and graphite. These raw materials are classified as "critical" and "strategic" in the European Commission's framework regulation (the Critical Raw Materials Act, CRMA) (see also insight 7). This means that these raw materials are considered to be of great economic importance to the EU and essential for the green transition, with rising demand and only limited potential for increasing production.

6.1 Strategic partnerships are a core instrument of the EU's raw materials strategy for diversifying trade partners

A core instrument of the European raw materials strategy is "strategic partnerships", which are to be established by the EU and implemented with the help of the member states. The overarching goal of these partnerships is to reduce dependence on individual countries (see insight 7 for more on this) for raw materials identified as critical and to diversify the countries from which the EU imports these raw materials or intermediate products. Cooperation with various reliable partner countries that have reserves will thus be crucial. Since 2021, the Commission has already established twelve partnerships and announced plans for further ones.[85] These include high-income countries such as Australia and Canada, but also middle- and low-income countries such as Argentina, Brazil, Chile, Ghana, Colombia and Namibia. Particular attention will be paid to local development opportunities through raw material extraction and the establishment of further stages of the value chain, especially in cooperation with developing economies. The Global Gateway, an existing investment programme by the European Union for infrastructure, is set to provide funding.[86] At present, partnerships in this scheme are based on memoranda of understanding (MoUs) that will need to be fleshed out in the future.

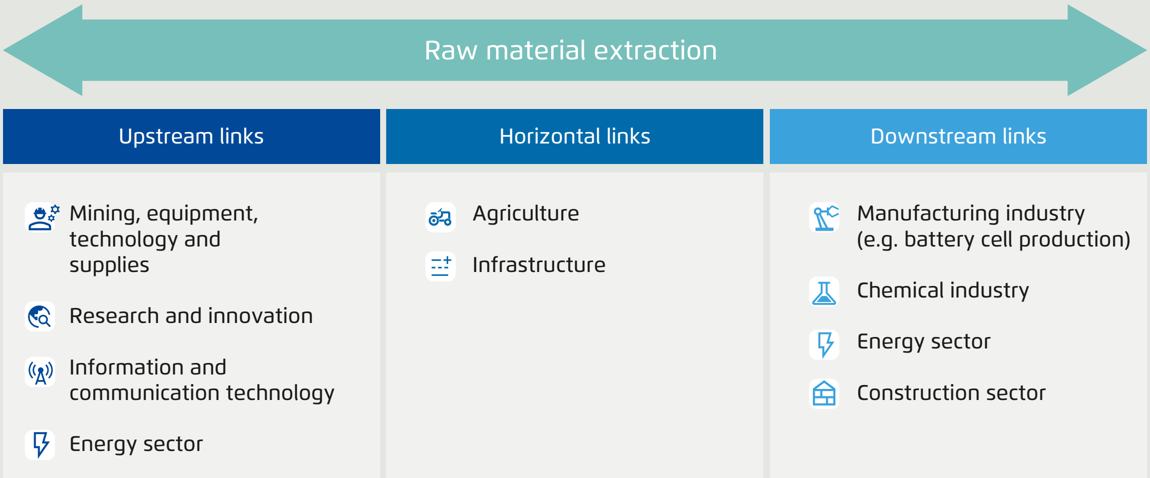
6.2 Strategic partnerships can contribute to a fair distribution of value creation in battery production

The global distribution of value added in the raw materials sector is currently uneven. Industrial mining projects in resource-rich countries are predominantly carried out by large multinational corporations.[87] The focus of these projects is often on exporting the unprocessed mineral product. This can have adverse consequences for local development if enclave-like economic structures emerge without links to upstream or downstream industries, the creation of high-quality jobs for the local population, or knowledge and technology transfer to local companies. Strategic partnerships that recognise and address these risks, in conjunction with other measures such as (adequately) equipped financing instruments, would allow for close cooperation with partner countries to establish cluster structures that include local economic actors in upstream and downstream industries, thereby supporting sustainable economic development.

Upstream industries in raw material extraction with high value-added potential are mainly found in research and development and in the provision of equipment, technology and infrastructure (see Figure 11).[88] There is potential here for local suppliers with contextual knowledge to work with mining companies to develop tailor-made solutions for local conditions. The development of such innovative solutions would also enable companies to achieve efficiency gains, while the local economy would benefit from more high-quality jobs and capital inflows, which would ultimately increase local social acceptance. Today, however, investing companies still often rely on established business partnerships with non-local suppliers. One task of strategic partnerships would therefore be to support countries in developing suitable support instruments for local suppliers and establishing regulations such as local content requirements (see insight 7 for further explanations).

85 SWP (2023).
86 European Commission (2023b).
87 Arias-Loyola, Atienza, Cademartori (2014).
88 SWP (2023).

Raw material extraction: high value creation potential in related industries — Figure 11



Agora Verkehrswende (2025) | Own depiction.

Downstream of raw material extraction are stages with higher value-added potential. These include further processing (smelting, refining) of raw materials into higher-value intermediate products and, ultimately, product manufacturing, such as battery cells and batteries. Today, almost 72 percent of cobalt mining takes place in the Democratic Republic of Congo, but 75 percent of the world's cobalt is processed in China, also home to 71 percent of battery cell production (see also Figure 12 in insight 7.1). The situation is similar for other raw materials designated as strategic, such as manganese and lithium. Thus, the vast majority of unprocessed raw materials mined are exported to other countries (mainly China) for further processing into higher-value products. As described above, battery cell production requires specific industrial conditions such as a reliable power supply, infrastructure, logistics, proximity to a potential market and, last but not least, expertise that cannot realistically be guaranteed in every mining country. At the same time, players such as the EU have an interest in locating this part of the value chain in their own countries (see insight 7). Mining countries, on the other hand, want to improve their position along raw material supply chains and are increasingly imposing export bans on unprocessed raw materials and adopting localisation strategies.[89]

These interests may appear diametrically opposed but they are not necessarily contradictory. The market for battery cells is experiencing strong growth and it is highly unlikely that a complex global supply chain can be located exclusively in one region or the other. However, it should be emphasised that the EU will not be able to supply itself autonomously with critical raw materials in the foreseeable future. The EU therefore has an intrinsic interest in concluding partnership agreements with countries rich in raw materials. In this context, resource-rich countries have an advantageous negotiating position in an environment of geopolitical competition and rising demand for raw materials. These countries can choose their partners carefully and will only accept offers that offer benefits for both sides.[90] The EU should therefore use context-specific and tailor-made strategic partnerships to accommodate countries with raw material deposits if it wants to diversify its partnerships for the procurement of critical raw materials and other components for battery production.

89 IRENA (2023).
90 SWP (2023).

This includes locating parts of the downstream stages of the supply chain with high value-added potential in the mining countries. In particular, the expertise of German companies in the field of mechanical engineering and the promotion of knowledge exchange with raw material-producing countries could, for example, encourage the refining or production of individual battery components (component manufacturing) to take place in these regions in the future, thereby generating additional jobs and (state) revenue.

6.3 Sustainability in mining needs to take environmental and distribution issues into account

Another important aspect of raw material extraction is the classification of the term "value creation" beyond its economic dimension.[91] In addition to establishing economic links, issues of wealth distribution and environmental impacts must also be considered. Studies show that populations living in mining areas often benefit little or not at all from the mining industry (see IRENA 2023). According to IRENA, up to 54 percent of the critical raw materials relevant to the energy transition are located either on or near the land of indigenous communities, with lithium accounting for as much as 80 percent. Despite the UN Declaration on the Rights of Indigenous Peoples, which includes the right to free, prior and informed consent (FPIC) to mining projects, for example, displacement and human rights violations continue to occur in and around raw material extraction projects. Local population groups are forced to live with the negative environmental impacts of mining, such as groundwater pollution.[92]

It is the responsibility of policymakers in consumer countries to ensure that companies are bound by accountability standards. At the same time, labour and human rights are violated in the mining process itself, especially in artisanal mining, which is often informal and unregulated. An estimated 45 million people worldwide work informally in mining.[93] However, measures to address these problems must consider the realities of people whose livelihoods often depend on income from mining.[94] Finally, mining itself is also responsible for significant CO_2 emissions and water consumption.[94] A transition to renewable energies and efficiency measures within the mining sector itself is therefore imperative. These problems must be addressed, when necessary, together with partner governments, if EU initiatives want to achieve a just transition of structural change towards a climate-neutral, resilient and socially just social and economic order.

In sum, strategic partnerships are primarily an offer from the European Union to resource-rich countries whose resources give them an advantageous negotiating position. Given its high dependence on raw material supply chains for battery production, the EU needs to win new partners and could focus on strategic partnerships to achieve this. However, the acceptance of such partnerships by resource-rich countries will depend largely on whether they bring concrete local benefits, such as the promotion of local industries and the establishment of cluster structures. This is particularly relevant for resource-producing countries such as the Democratic Republic of Congo, as global demand for cobalt is subject to considerable fluctuations and may grow less in the future than originally assumed (see insight 5). A unilateral economic focus on the export of unprocessed raw materials poses considerable risks for these countries, as it increases their vulnerability to price fluctuations and declines in demand. In the long term, this could exacerbate economic instability, hamper economic diversification and make it more difficult to establish sustainable industrial value chains.

The CRMA and other partnerships concluded so far remain vague in this regard. Although the regulation addresses local economic development, it does not specify steps or stipulations. Environmental and social consequences are also only addressed in passing. Additional regulatory, financial and collaborative instruments are therefore needed to ensure sustainability. With the Battery Regulation, the EU laid the foundation for supply chain monitoring requirements with respect to for human rights violations. Further expansion of financial support is essential to effectively implement raw material partnerships. This could be achieved

91 Heinrich Böll Foundation (2023).
92 Fern et al. (2023).
93 IRENA (2023).
94 Jønsson, Fold (2011).

through loans or guarantees for mining projects from development and investment banks, such as the Kreditanstalt für Wiederaufbau (KfW) and the European Investment Bank (EIB), the establishment of an EU raw materials fund or financing from the Global Gateway, and trade agreements (free trade agreements). However, these should also be linked to sustainability criteria accounting for economy, ecology and social issues. Finally, collaborative instruments such as development cooperation and academic exchange are key to promoting local capacities, innovation and the emergence of related businesses.

7 | Resilience requires raw material processing and component manufacturing in Europe

Unilateral import dependencies and the related issue of the resilience of international value chains have become increasingly important in recent years.[95] The relocation of larger parts of the value chain to Europe is part of a general resilience strategy for critical raw materials and intermediate products (see insight 3.3). In this context, securing raw materials (see insight 6) and manufacturing battery components within the Union are particularly important. As indicated above, there are strong dependencies on individual countries at these stages of the value chain today.

7.1 Asia also clearly leads in the midstream stages of the battery value chain

Leaders in cell production (see insight 2) also hold large parts of the manufacturing value chain. The Economist puts the figure at 92 to 100 percent of the middle parts of the value chain for China, South Korea and Japan combined.[96] Fraunhofer ISI points out that 98 percent of anode and separator production is in the hands of Chinese, Japanese and Korean companies, while the figure for cathode production is 92 percent and for electrolyte production as high as 100 percent. In contrast, European companies such as BASF and Umicore account for less than 1 percent and 6 percent of cathode production, respectively.[97] Figure 12 illustrates this relationship. China's position is particularly striking. In addition to the high market shares for refined products, more than 70 percent of component manufacturing and almost 80 percent of battery cell production for electric vehicle batteries takes place in China (see Figure 12). In addition to the current shares of various countries in the value chain for cathodes, anodes and battery cells, the figure also shows the European Union's targets for 2030 (see insight 7.2).

The example of gallium shows that these dependencies can be detrimental to the development of a resilient battery value chain in Europe. In July 2023, the Chinese government decided to restrict exports of gallium, which had a global impact on semiconductor production and was perceived by some nations as a threat to their national security. China currently produces around 80 percent of the world's gallium, which can only be processed in plants in China, Japan and by one company each in Europe and Canada.[98] It is conceivable that similar decisions could be taken for raw materials and components that are strategic for batteries. Conversely, European companies such as semiconductor equipment manufacturers are also subject to export restrictions imposed by the US and the Netherlands on exports to China.[99] In view of increasing geopolitical tensions, it appears necessary and advisable to locate the middle stages of the value chain in Europe and to build up in-house technological expertise in all relevant processing steps.

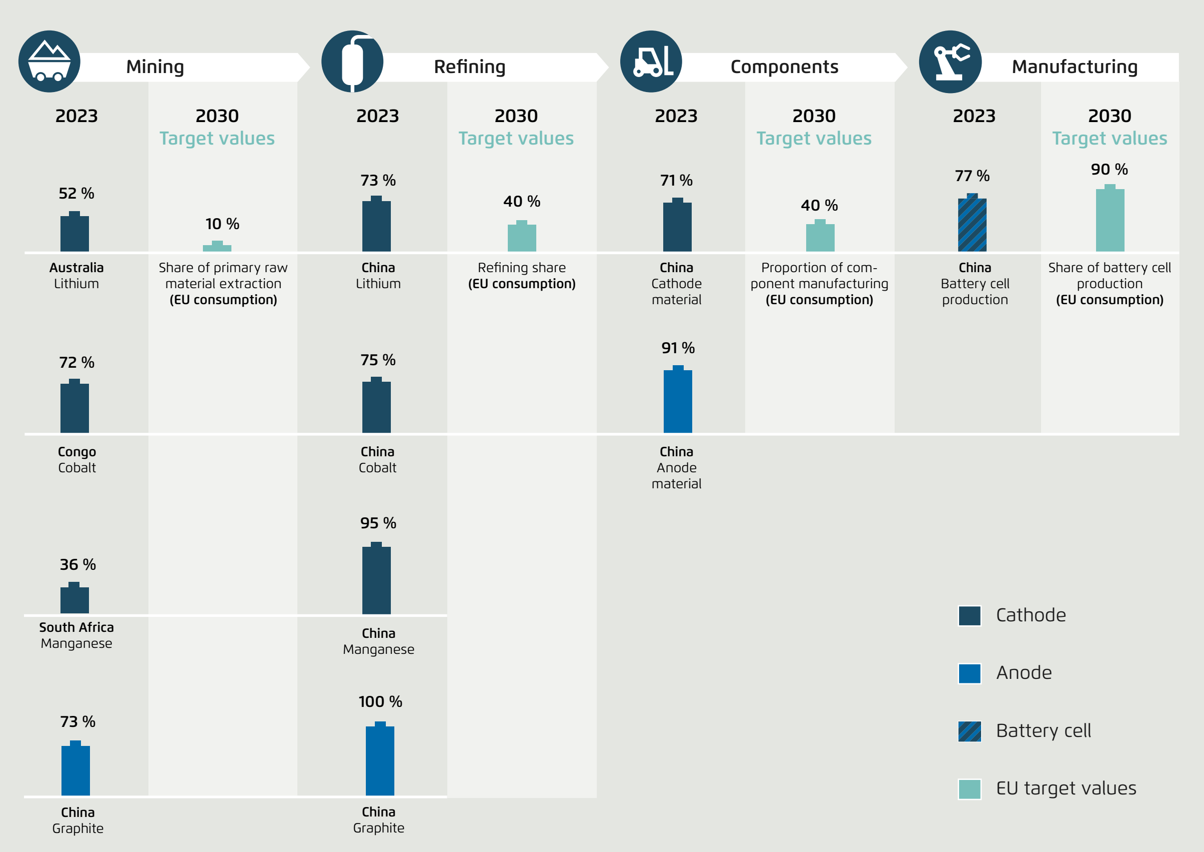
7.2 The Critical Raw Materials Act and Net-Zero Industry Act are first steps towards greater resilience and intra-European production

To foster European resilience, the European Union has adopted the CRMA and the Net-Zero Industry Act (NZIA). Together, these two pieces of legislation form a legal framework that addresses problems of dependence and availability with respect to raw materials classified as critical in the event of supply bottlenecks (see insight 6). In addition, component manufacturing is identified as essential for creating expertise, innovation and high-quality jobs in battery technology and for establishing industrial clusters. The adopted regulations aim at ambitious European minimum shares in all steps of the value chain and at accelerating the approval processes for cell factories and key industrial companies.

According to the CRMA, the EU should be able to extract 10 percent of its annual consumption of strategic raw materials, process 40 percent and recycle 25 percent itself by 2030. The same benchmark applies to component manufacturing, i.e., intra-European manufacturing capacities should be able to cover at least 40 percent of EU demand by 2030 (see Figure 12).[100] The

95 Prognos, Öko-Institut, Wuppertal Institute (2023).
96 The Economist (2023a).
97 Fraunhofer ISI (2023b).
98 Heinrich Böll Foundation (2023).
99 Handelsblatt (2025).
100 Regulation (EU) 2024/1735.

European minimum shares are required at all stages of the battery value chain — Figure 12



Agora Verkehrswende (2025) | Sources: Stiftung Klimaneutralität, Prognos, Öko-Institut, Wuppertal Institut (2023).

NZIA has also set a target that 40 percent of "net-zero technologies" be produced within Europe. This includes battery and storage technology as well as other technologies, such as photovoltaics, onshore wind power and heat pumps. These targets represent a first step towards European minimum content requirements, an industrial policy tool designed to stimulate local production and thus value creation. Member states should take resilience into account in public procurement for net-zero technologies or their key components that originate from a third country for more than 50 percent.[104] The communication on the Clean Industrial Deal underscores the Commission's intention to take further supporting measures on net-zero technologies, with additional legislative proposals announced, for example, to simplify approval procedures.

Such regulations can serve to make supply chains more robust and strengthen national and regional strategic autonomy. But actual implementation is crucial. So far, there is a lack of concrete implementation mechanisms and sanctions for non-compliance, and as such, their steering effect remains questionable in practice. The CRMA and NZIA assign responsibility for introducing penalties to member states, which may lead to divergent implementation within the EU.

7.3 The implementation of reshoring and nearshoring strategies is accompanied by inevitable conflicts of interest

The laws described above bring advantages, but they also entail risks. These include increased costs, the loss of economies of scale and possible retaliatory measures by affected countries. Reshoring, or the relocation of production processes back to the company's country of origin, and nearshoring, the relocation of production activities to nearby partner countries that share the same values, could entail higher costs than sourcing from more distant, lower-cost suppliers. Policies to promote domestic mining and processing could also require trade barriers, which could damage trade relations and raise concerns about protectionism. Furthermore, as indicated above, localisation efforts are not automatically successful if a country lacks technological capabilities, human capital, industrial infrastructure and favourable investment conditions.

Restructuring supply chains requires a balance between economic considerations, environmental concerns and the well-being of local communities. In Germany, the environmental and human costs of mining and processing raw materials, including lithium and rare earths, from distant countries remain largely invisible to the local population. Countries must address these trade-offs if they want to diversify their supply chains. A key issue for CRMA requirements, for example, is that strategic mining, refining and recycling projects can be classified as projects of overriding public interest – which means that they override environmental laws.[101] This has already led to significant civil society protest movements. In Serbia, for example, the development of the Jadar lithium mine (one of the largest lithium deposits in the world) is facing increasing resistance, with local communities expressing concerns about the mine's potential environmental impact, particularly in terms of water contamination and their displacement.[102] Similar protests have taken place against other lithium projects in Europe, including in Portugal, Spain and Germany. It is important to minimise environmental problems and resolve the social issues associated with the extraction of raw materials in Europe as elsewhere. Otherwise, such protests and others could lead to delays in mining projects in Europe and, at the same time, maintain dependence on third countries.

In sum, the European Union has recognised the need for action and has adopted comprehensive regulations and further strategies that could improve supply chain stability and promote value creation through battery production within the Union. At the same time, many questions concerning the achievability and actual implementation of the targets remain open. Targets must be accompanied by additional measures including joint ventures, improving investment conditions and targeted promotion of skilled workers. Resilience efforts must also involve and respect civil society concerns.

101 IRENA (2023).

102 Tagesschau (2024).

8 | Promoting European battery recycling boosts resilience and competitiveness

A recycling industry in Europe is a key building block for greater resilience in raw material supply and more stable value chains. Recycling can reduce the share of primary raw materials required, promoting supply security while minimising the negative impacts of mining. In theory, battery raw materials can be recycled indefinitely. This is the central promise of the circular economy. Recycling would not only reduce the demand for primary raw materials, but also cut emissions (PEM RTWH Aachen et al. 2021).[103]

8.1 A thriving recycling industry in Europe is important for greater resilience in raw material supply

Estimates vary on the proportion of raw material requirements for electric mobility that can be covered by secondary materials. If 80 percent of available lithium were recycled, the Öko-Institut estimates that 12 percent of Germany's lithium demand for the mobility sector could come from secondary materials by 2035. This figure rises rapidly to 27 percent for 2040 and 41 percent for 2045.[104] Another study assumes that the combined global annual demand for primary cobalt, lithium, manganese and nickel for electric vehicles (including light and heavy commercial vehicles) could be reduced by 3 percent in 2030, 11 percent in 2040 and 28 percent in 2050. This study assumes that only 50 percent of the theoretically available material will be recycled.[105] The International Energy Agency predicts that recycling could reduce global primary demand for copper and cobalt by 40 percent and for lithium and nickel by 25 percent by 2050.[106] These projections illustrate the potential of recycling.

But as long as demand exceeds supply, there will continue to be a need for primary raw materials and investment in new mines.[111] Against this backdrop, increasing recycling capacities in Europe is crucial. Accordingly, the CRMA (see insight 7) has set a target for the European Union to build the Union's recycling capacity so that it is able to produce at least 25 percent of the annual consumption of strategic raw materials in the Union by 2035.[107]

103 PEM RWTH Aachen, BLB TU Braunschweig, VDMA (2021).
104 Öko-Institut et al. (2023).
105 ICCT (2023).
106 IEA (2024b).

8.2 The number of European recycling sites is growing – but technical and economic uncertainty remains

Recycling lithium-ion batteries is technically possible. There are already recycling sites in many European countries, including Belgium, Germany, Finland, France, Norway, Poland, Spain and Hungary. There are different approaches to recycling lithium-ion batteries, and combining different techniques results in a variety of different process routes.[108] In general, the following steps are relevant: collection and dismantling of batteries from existing and end-of-life vehicles, collection of end-of-life batteries, sorting, dismantling and discharging, and thermal and/or mechanical pre-treatment to produce black mass or other recyclable material concentrates[109]. For the material recovery of metals, metallurgical-chemical processes are required as a subsequent step, consisting either of a pyrometallurgical initial step followed by hydrometallurgy or of direct hydrometallurgical processing of black mass or concentrates. Pyrometallurgy refers to the melting of materials in a blast furnace in a metallic phase, a slag and a fly ash/gas phase. Hydrometallurgy describes the extraction and purification of important metals or metal salts through a chemical process. Hydrometallurgical processes are ultimately required to process battery raw materials to such an extent that they can be reused as secondary materials in batteries.[110] In practice, there are a variety of process approaches and combinations, each with specific advantages and disadvantages and different requirements in terms of homogeneity and preparation of the input material. Depending on the process approach used, some sub-steps such as discharge, thermal pre-treatment or mechanical black mass production may also be omitted.

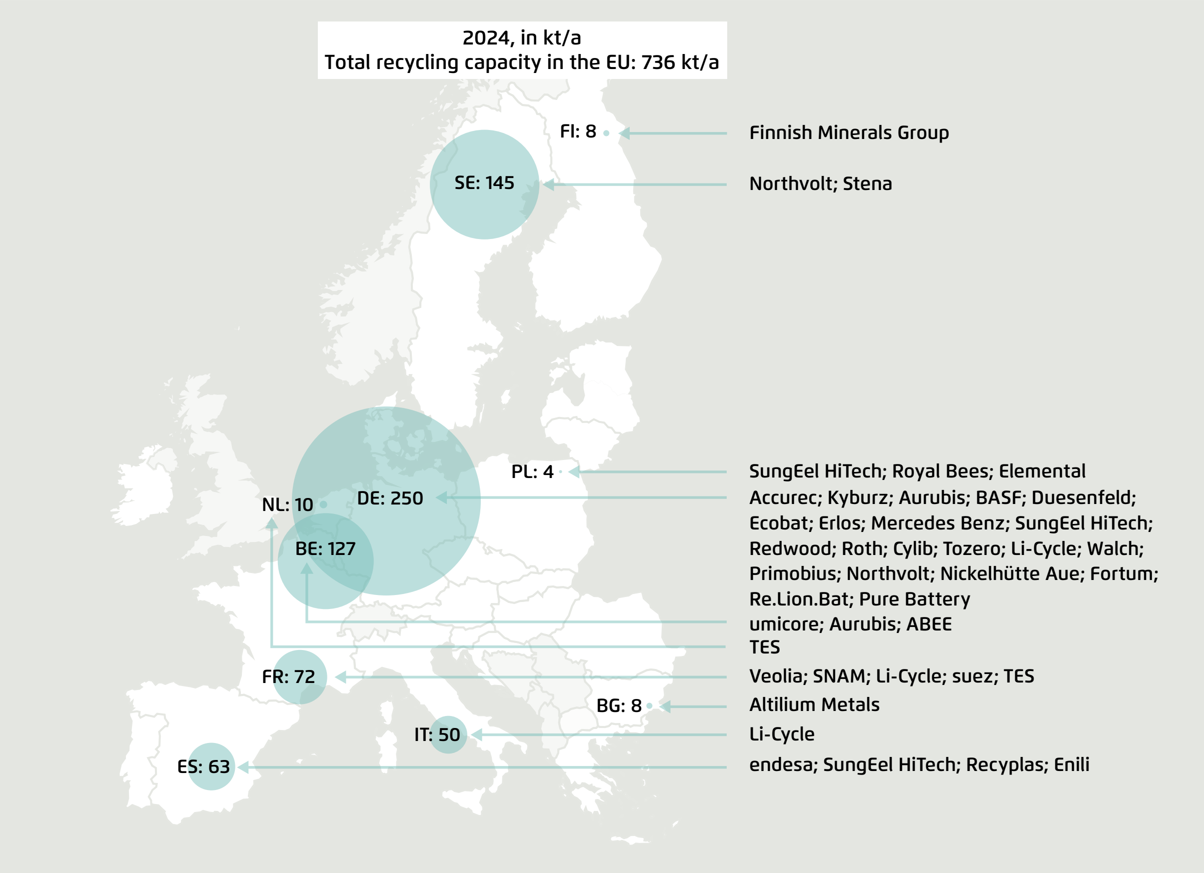
107 Regulation (EU) 2024/1252.
108 PEM RWTH Aachen, BLB TU Braunschweig, VDMA (2021).
109 This refers to the collection and dismantling of batteries from existing vehicles when they are defective.
110 ZVEI (2020); BGR (2022); Mercedes-Benz Group (2024).

During the ramp-up phase of electric mobility, existing facilities for recycling vehicle batteries are mainly fed by production waste rather than end-of-life batteries. Proximity to cell production sites can therefore be a relevant criterion for the decision to settle on a recycling location, as this makes it possible to keep transport distances for defective batteries and production waste short, which in turn has a positive effect on logistics costs.[111] Germany is currently the European leader in terms of the number of recycling companies and the number of sites announced for the coming years (see also Figure 13). Accordingly, Germany, as Europe's largest automotive market, could benefit disproportionately from battery recycling.

111 VDI/VDE-IT (2023b).

Different recycling sites can implement different steps: from the discharge and dismantling of traction batteries to the shredding and processing of waste into black mass and pyro-/hydrometallurgical metal recovery. Black mass is produced by mechanically shredding battery modules or cells and separating an aluminium fraction, a copper fraction and, if necessary, other residual materials from the shredder output. The term black mass refers to the remaining mixture of cathode and anode material and contains relevant battery raw materials such as lithium, cobalt and nickel in the form of metal concentrate. During the metallurgical processing of the black mass, the battery metals can be recovered and used for the production of new cathode materials. The distribution of plants in Europe is uneven: the first processing steps

Battery recycling: Germany well positioned as a location — Figure 13



Agora Verkehrswende (2025) | Data as of September 2024. Recycling to black mass or metal precursors. The recycling capacity shown per country includes both already implemented and announced projects. The information is not exhaustive. Source: battery-news.com (2024).

are decentralised, while the recovery of raw materials from processed black mass, battery modules or cells takes place or will take place at a few locations in Europe. So far, most industrial-scale plants for processing black mass in Europe are at the announcement stage.[112]

The European Battery Regulation sets the legal framework for the recycling of electric vehicle batteries in Europe – with far-reaching requirements. By 31 December 2027 at the latest, targets for material recycling will be 90 percent for cobalt, nickel and copper and 50 percent for lithium.[113] These will be increased to 95 percent for nickel, cobalt and copper and 80 percent for lithium by 31 December 2031. New investments underway in additional recycling plants in Europe will facilitate these high recovery rates.[114] A further increase in the number of sites is expected by 2030, with sufficient metallurgical recycling capacity for the traction batteries generated in Europe in the medium term (see also Figure 13).[115]

Investment periods in the recycling industry are long, and the industry is subject to technical and economic uncertainty. Technical uncertainty arises from the changing chemical compositions of battery components (see insight 5). This leads to a dilemma: changing battery chemistry means the demand for recycled cobalt or nickel could decline at precisely the moment when secondary materials are recovered. One way to hedge against this is to ensure that recycling plants are capable of processing different input materials. The economic uncertainty relates to the value of the recovered materials. The profitability of recycling processes changes fundamentally when inexpensive materials rather than expensive materials such as cobalt, nickel or lithium are used in LFP or sodium-ion batteries, whose share – at least in relation to LFP – will continue to rise in the future (see insight 5). The cheaper the battery materials used (LFP, sodium-ion, etc.), the less profitable recycling tends to be. However, high demand for lithium is also expected in the future (see insight 5). This, together with the investment announcements made to date, suggests that market players generally expect profitable business models.

Technical or economic uncertainty alone is not an obstacle to investment. High uncertainty is usually accompanied by high profit prospects. But the ramp-up of the European recycling industry is taking place in an environment of increasing international competition for technology investment and development. If European investment restraint meets Chinese and American investment enthusiasm, large recycling industries will emerge or remain outside Europe. Under this scenario, it is unlikely that the European supply security targets defined in the CRMA will be achieved.

8.3 A key challenge is access to raw materials

Predictions under business-as-usual assumptions hold that batteries from old electric vehicles will not account for a larger share than production waste before 2030.[116] But the current delay in the ramp-up of electric mobility in Germany is leading to an uncertain domestic investment climate, even as electric mobility continues to grow worldwide.[117] Competition from other world regions with generous subsidy schemes is delaying or even relocating investment projects for cell production facilities in Europe. Fewer gigafactories in Europe mean less production waste in Europe – and thus less input during the ramp-up of battery recycling. Announced large recycling projects are already reporting delays.[118]

Another challenge for recycling in Europe is the closure of material cycles. Global supply chains exist not only for raw materials and battery components, but also for recycled materials. In this context, the export of black mass should be mentioned, which leads to an outflow of critical raw materials that are then not available to the European recycling industry.[119] Although the further processing of black mass is not yet possible on an industrial scale in Europe, a permanent outflow of this material

112 BASF (2023); Li-Cycle (2023); Umicore (2023); VDI/VDE-IT (2023b); Mercedes-Benz Group (2024).
113 PEM RWTH Aachen, BLB TU Braunschweig, VDMA (2021); Regulation (EU) 2023/1542.
114 BASF (2023); Mercedes-Benz Group (2024).
115 BGR (2022); VDI/VDE-IT (2023b).
116 Battery News (2024).
117 IEA (2024a).
118 Randall (2024).
119 Simon (2023).

stream is not advisable.[120] In this regard, the Commission's announcement that it intends to change the waste classification of black mass is a positive step that would halt exports to non-EU countries.

It is unclear whether electric vehicles registered in Europe will remain in Europe for their entire service life and be returned to recycling as end-of-life vehicles or exported to other countries outside Europe as used cars. The export of used electric vehicles would also mean that these raw materials would be lost for recycling in Europe. Securing a supply of raw materials is crucial for a competitive recycling industry in Europe. It is therefore important that the EU ensures a coherent regulatory framework in this area. Regarding the export of used vehicles, the legal provisions are currently under revision and may be tightened slightly. However, the issue of exporting used electric vehicles, particularly to partner countries in Africa, has not yet been comprehensively analysed. Further research and discussions with African partner countries regarding their political goals and instruments for decarbonising the transport sector are needed.

In the long term, the switch to electric mobility will require new business models in the automotive industry. There is a particular need for greater involvement both upstream and downstream in the value chain. Vehicle leasing or to offer attractive buy-back deals for used vehicles should be promoted to increase the recycling of battery raw materials. Further market potential could also be tapped during the vehicle's usage phase, for example, by bundling vehicle services with (controlled or bidirectional) charging services.

Regulation is the most important safeguard against technical and economic uncertainties and for closing material cycles. The Battery Regulation stipulates ambitious recovery rates and prescribes minimum recycled content in new batteries for various battery materials. These material-specific recycling quotas help cushion the economic uncertainty surrounding battery technology development to a degree. The CRMA also falls into this category, as the European target of recycling at least 25 percent of the annual consumption of strategic raw materials in the Union is also likely to have an incentive effect. The same applies to the Corporate Sustainability Reporting Directive[121], which requires companies to report on CO_2 emissions across the entire value chain by 2026 at the latest.

However, the importance of the recycling industry for the resilience of Europe as a battery location calls for further framework conditions. This includes medium-term targets to ensure that neither black mass nor end-of-life electric vehicles are exported from Europe, but also additional support measures, such as, for example, financial support through the European mechanism of the Important Project of Common European Interest (IPCEI) or other financial instruments. In its recently adopted Automotive Action Plan, the European Union announced that it would examine financial support for facilities for the recycling of end-of-life vehicles and batteries and enable industrial cooperation in compliance with EU competition law.[122] This is a welcome step. Further key steps include increasing transparency with respect to the actual material flows at the end of a product's life, for example through product passports and efficient tracking and tracing systems and anchoring the issue within a coherent industrial policy in Europe.[123] The circular economy announcements in the Automotive Action Plan are welcome, but the details must be clarified.

120 European Commission (2025b).

121 Directive (EU) 2022/2464.

122 European Commission (2025b).

123 Resource Commission at the Federal Environment Agency (KRU) (2023).

9 | A European industrial policy for batteries is needed

In her political guidelines for the new European Commission, Commission President Ursula von der Leyen stated: "The future of the clean and cutting-edge tech industry must be made in Europe." But the reality is still far from this goal. Technological leadership in batteries lies in Asia, and a combination of intense price pressure globally and difficulties in industrial scaling and a shortage of skilled workers within Europe are creating difficult competitive conditions for European companies. At the same time, German and European industry is dependent on cooperation with Asian players, and the European Union must push ahead to establish value chains in Europe. There is a risk that, rather than Europe becoming the place where future technologies for the global market are developed, the opposite scenario could occur.

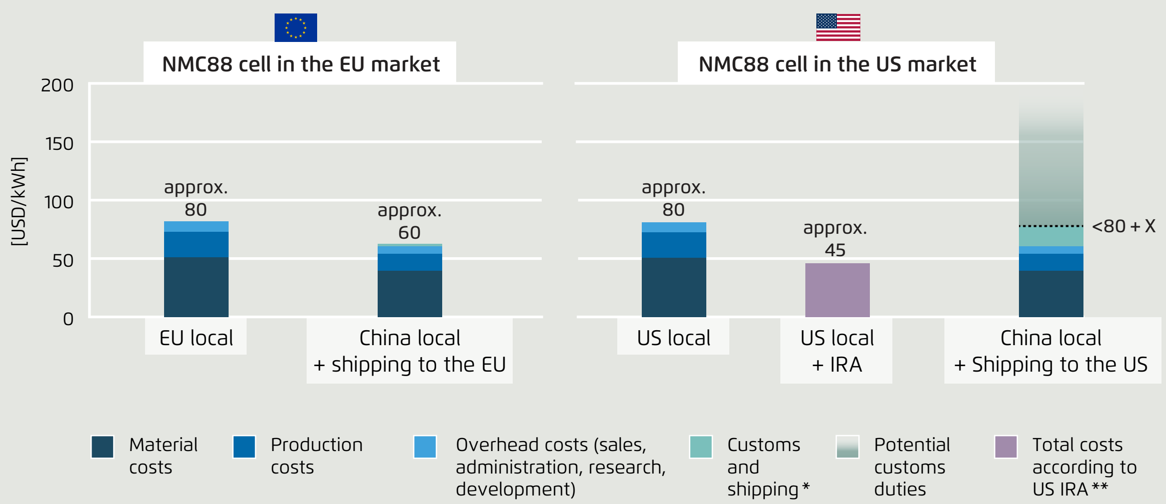
9.1 Europe as a battery ecosystem needs a clear commitment to electromobility

China has significant overcapacity in cell production compared to domestic demand, and further overcapacity is predicted (see insight 1.2).[124] Overcapacity in cell production in China means that more cost-effective imports of technologically attractive battery cells to Europe are to be expected at a time when the European battery industry is struggling with considerable start-up difficulties. The different political frameworks in Europe and the US are exacerbating this dynamic. For example, US industrial policy under the IRA, including the tariff policy framework, has meant that cells manufactured in the US can leverage an effective cost advantage over cells imported from China after subsidies. This makes the American market relatively unattractive for Chinese manufacturers.[125]

In comparison, Chinese manufacturers have significant cost advantages over cells manufactured locally in Europe. The target costs calculated by Roland Berger, excluding margins, are extremely low, at 60 US dollars per kilowatt hour for high-nickel NMC88 cells.[126] This

124 PEM RWTH Aachen, Roland Berger (2025).
125 PEM RWTH Aachen, Roland Berger (2025).
126 An NMC battery is a lithium-ion battery with a cath-

Model costs are influenced by political conditions in the markets — Figure 14



Agora Verkehrswende (2025) | * 2.7% customs duty on imports into the EU. Total customs duties on imports into the US: 26.73% (most-favourednation tariff + Section 301 tariffs). Further development of customs duties in the US unclear (expressed as "X"). ** 35 USD/kWh for cell production, additional benefits amounting to 10% of production costs for components and 10 USD/kWh for module assembly (future of the IRA unclear). As of 6/2025. Source: Roland Berger (2025).

falls significantly below the 80 US dollars per kilowatt hour calculated for Europe. As under the adopted One Big Beautiful Bill Act, the updated Section 45X rules of the IRA continue to provide a production tax credit for battery components, there is likely to remain a clear incentive for Chinese manufacturers to continue to develop Europe as a sales market. This could be further exacerbated by the continued isolation of the US market from Chinese imports, with the result that surplus Chinese production capacities would increasingly enter the European market and create intense price pressure, which could further worsen the competitive conditions for European suppliers. Discussion about the structure of tariffs is dynamic, and it is unclear how customs regimes worldwide will develop further.

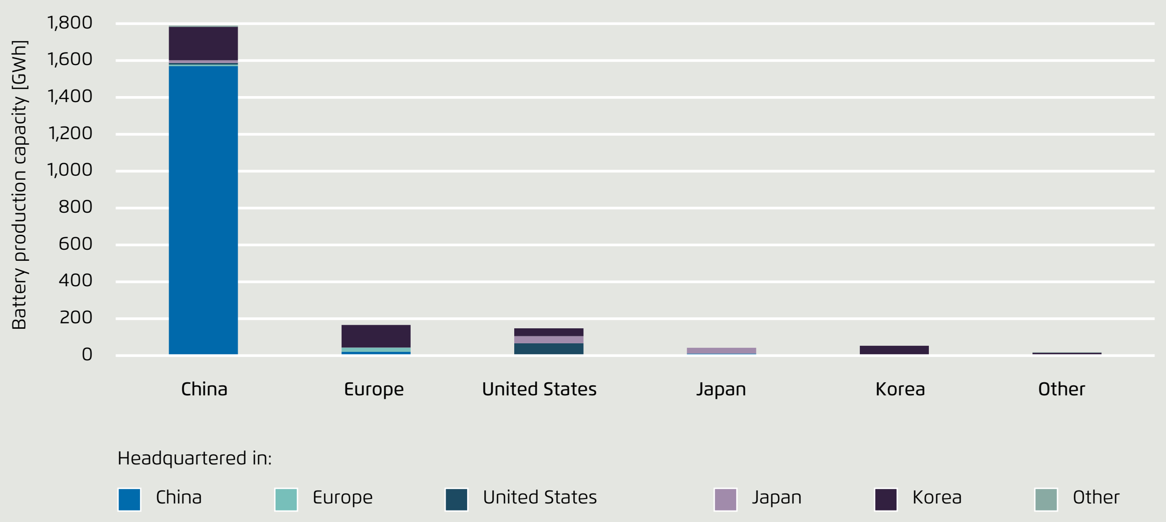
Figure 15 shows the regional distribution of battery production capacities worldwide in 2023. Europe ranks second, but far behind China and with only a slight lead over the US. In addition, many of the batteries produced within Europe come from companies headquartered in Asia, which highlights the catch-up potential of European companies. The latest IEA data shows a shifting landscape: China remains in the lead, while the US has climbed to second place with nearly 50% growth, likely spurred by the IRA subsidies.[127] Although most producers in the US are still Asian—primarily Korean—a significant share of domestic companies is also active. In Europe, by contrast, local firms continue to struggle. Battery production in the EU has grown by about 10%, but the sector remains largely dominated by foreign companies.

As electric mobility continues to rise, further investments have been announced for the coming years. But according to the latest Battery Monitor, more capacity has been announced than expected, both in China and in Europe.[128] It will be important to determine which announced projects will be implemented and whether this will happen within or outside Europe. Where these investments will take place will define the global location of the battery value chain for years to come. However,

ode made of lithium-nickel-manganese-cobalt oxide. In NMC88, the metals nickel, manganese and cobalt are present in the following proportions: nickel accounts for 88 mole percent, manganese and cobalt together account for 12 mole percent.

127 IEA (2025)
128 PEM RWTH Aachen, Roland Berger (2025).

Regional battery production: Asian companies as the driving force — Figure 15



Agora Verkehrswende (2025) | Data as of 2024. Europe is understood here in accordance with the geographically oriented definition of the IEA and also includes non-EU countries such as Norway, Switzerland and the United Kingdom. Source: IEA (2024).

if no further elements of the battery value chain are established in Europe, or if further projects in Europe are abandoned or become insolvent due to the difficulty of mastering the start-up phase of plants over a longer period, the structurally high dependence on China will remain unabated.

In Germany in particular, recent political decisions did not sufficiently promote the localisation of the battery value chain: following the Constitutional Court's ruling on the German Climate and Transformation Fund (KTF) on 15 November 2023, battery research funding was to be cut massively and on short notice.[129] Even though the Federal Ministry of Research approved funds for bridging financing in January 2025 and the new coalition agreement refers to the importance of reliably establishing and expanding battery research,[130] the back-and-forth on research funding in Germany has led to considerable uncertainty. The short-term cancellation of the purchase premium for electric cars, also related to the KTF ruling, caused sales of electric vehicles to collapse in 2024. In addition, months of debate about the phase-out of combustion engines in Germany and the withdrawal or postponement of group-wide electrification targets by OEMs have created a climate of uncertainty.[131] This has already had knock-on effects for announced battery cell plants, such as the planned ACC plant in Kaiserslautern, where media is reporting construction delays, partly due to the decline in electric vehicle sales.[132] SVOLT also cancelled its cell factory in Saarland and its announced battery factory in Brandenburg for the same reason.[133] Announcements of this kind are causing further knock-on effects for the European battery ecosystem: BASF recently announced that the construction of a battery recycling hub in Spain would be delayed due to the delayed construction of battery factories in Europe.[134] In August 2025, Porsche announced to largely discontinue its subsidiary Cellforce. [135] The Swedish parent company of Northvolt Germany, Northvolt AB, has also filed for bankruptcy in Sweden. [136] In August 2025, the US company Lyten announced plans to take over the Northvolt plants in Sweden and Germany (under construction).[137] At the time of writing, it is not clear to what extent the budgetary situation will allow for adequate future funding of the battery value chain, even after the new special fund for infrastructure investment and climate neutrality was approved. The new German government's coalition agreement at least emphasises the importance of battery research and announces funding for battery cell production, including raw material extraction, recycling and mechanical and plant engineering. It also mentions new incentives to buy electric vehicles.[138] It is crucial that the German government ensures sufficient funding for both areas

Germany and Europe need to commit to electric mobility. This means staying on track with key Green Deal legislation, such as the phase-out of combustion engines in 2035. This EU will need to continue adhering to the CO_2 fleet limits for passenger cars agreed in the Green Deal. This legislative framework is important for planning and investment security, for attracting the battery industry and for providing clarity on the direction of the automotive industry's transformation. However, the latest decisions at EU level regarding the flexibilisation of penalties send the opposite political signal and risk contributing to a delay in the ramp-up of electric mobility. One thing has become clear: a delay in the ramp-up of electric mobility in Germany is not desirable – it reduces competitiveness and carries the risk of long-term job losses.[139] But current developments in the US, such as the shifted focus towards fossil fuels and the phase-out of tax incentives for EV purchases, show that a possible deterioration in the framework conditions for future industries in the US under the Trump presidency could also offer Germany and Europe the opportunity to attract companies, regain competitive advantages and modernise industry in a future-proof manner through reliable policies and targeted investments in emission-free technologies.[140]

129 Westerheide (2024a); (2024b); BMBF (2025).
130 CDU/CSU, SPD (2025).
131 See, for example, Henßler (2024); Hubik (2024); Tyborski, Fasse (2024); Business Insider Germany (2025).
132 Randall (2024a).
133 Westerheide (2024b); Treiß (2024).
134 Randall (2024b).
135 Die Zeit (2025).
136 Westerheide (2025).
137 Treiß (2025)
138 CDU/CSU, SPD (2025).
139 Agora Verkehrswende (2024).
140 DIW (2025).

9.2 Additional requirements for European minimum quotas are needed to establish the battery value chain in Europe

A commitment to electric mobility alone is not enough, even in Europe. Location factors need to be improved at many levels to regainsecond place in the global race for battery locations. The Draghi Report provides a concise analysis of the situation. According to the report, the critical situation facing the European climate protection technology industry is primarily due to the lack of an overarching European industrial policy. It identifies three key factors: "Manufacturers in the EU suffer primarily from the lack of stability in demand and the cost gap in production, which is exacerbated by unequal competitive conditions as other major economies provide substantial subsidies and erect trade barriers."[141] The lack of clarity in direction has contributed to the instability of demand, both at the level of the European Commission and through very inconsistent policy instruments of the member states to promote electric mobility. The issue of production cost differentials can only be mitigated if more comprehensive financing for the battery value chain in Europe is provided and support instruments are fundamentally revised and simplified in line with the American model (see insight 9.3).

During the last EU legislative period, the member states and the European Commission launched multiple legislative initiatives aimed at strengthening Europe's position in the battery industry, including the Critical Raw Materials Act, the Net-Zero Industry Act and the Battery Regulation, all of which have been mentioned in this paper. These initiatives formulate a series of requirements that can be understood as a basic framework for local minimum requirements with the aim of developing a greater portion of the battery value chain in Europe. This includes promoting raw materials, local content requirements in public procurement and targets for used battery recycling (see Table 1). The Clean Industrial Deal and the Automotive Action Plan expand this existing set of rules. The "Battery Booster" is noteworthy here, which proposes measures at all segments of the value chain to increase Europe's viability as a site of battery activity: from research funding and the possibility of joint purchasing for raw materials between different European players to simplifications in approval procedures for raw material projects in the EU and plans to promote the circular economy. This is a good first step.

141 Draghi (2024).

Objectives in the Critical Raw Materials Act, Net-Zero Industry Act, and Battery Regulation — Table 1

Objective		Target value	Deadline	Regulation
Strategic raw materials in Europe	Extraction	10 %	2030	*Critical Raw Materials Act* (EU) 2024/1252
	Processing	40 %		
	Recycling	25 % *		
	Component manufacturing	40 %		
Batteries	Manufacturing	90 %	2030	*Net-Zero Industry Act* (EU) 2024/1735
Local content requirements (public procurement)		> 50 %	Ongoing	
Targets for the recycling of used batteries	Lithium	50 %–80 %	2027/2031	*Battery Regulation* (EU) 2023/1542
	Copper, Cobalt, Nickel	90 %–95 %		
Recycling efficiency	Lithium-ion batteries	65 %–70 %	2026/2031	
Minimum content of recycled materials	Cobalt	16 %–26 %	2031/2036	
	Lithium	6 %–12 %		
	Nickel	6 %–15 %		

Agora Verkehrswende (2025) | * 25 percent of strategic raw materials should come from recycling.

The announcement to introduce local content requirements for batteries and other components of electric vehicles as part of a future legislative proposal under the Industrial Decarbonisation Accelerator Act is also significant. These minimum requirements are to be gradually increased as European production capacity rises.[142] In conjunction with other policy instruments, this should provide an incentive for investment in Europe and is very welcome. But it would be far from sufficient as a stand-alone measure, insofar as it does not address the cost gap between Europe and Asia or the knowledge advantage of Asian competitors (see insight 2).

9.3 The Automotive Action Plan foresees battery joint ventures but leaves financing unresolved

Against this backdrop, two instruments in the Automotive Action Plan should have an impact in precisely this area: production subsidies and joint ventures. For the first time, output-based production support had been announced for companies manufacturing batteries in the EU. This would be a sensible addition to local minimum quotas, as it should mitigate the higher production costs in Europe. Such an instrument has the potential to be much simpler and less bureaucratic than the existing European investment promotion instruments. Under the recently adopted European State Aid Guidelines ("Clean Industrial Deal State Aid Framework," CISAF), output-based production support at the Member State level have been ruled out.[143] At the EU level, however, such aid would be permissible. One potential approach could be a "Payment-for-Difference" mechanism, modelled on the European Hydrogen Bank.

In the Automotive Action Plan, the Commission proposed that these cash payments should be available to European players as well as investors from third countries who produce in Europe – albeit in conjunction with requirements to form partnerships with European companies that include an element of knowledge transfer.[144] One possible outcome is joint ventures with a European majority stake that must ensure technology transfer.

142 European Commission (2025a).
143 European Battery Alliance (2025).
144 European Commission (2025a).

Insofar as European industry is dependent on technology transfer, primarily from Japan, South Korea and China, this proposal is also to be welcomed.

Given the strategic importance of the battery industry and its ecosystem, dedicated European instruments are required to provide adequate support to strategic industries. This is particularly important for Southern, Central and Eastern Europe, as these EU Member States are often unable to mobilise the same financial resources as larger EU members such as Germany and France.[145] The Commission's plans remain vague on financing and do not provide enough money. The Commission has already announced three billion euros from the EU Innovation Fund for electric vehicle battery production, of which one billion was released in December 2024. The remaining two billion from various financial instruments are earmarked for the next two years, including 200 million euros from the InvestEU programme, which will enable additional risk-sharing operations by the EIB Group between 2025 and 2027.[146] In contrast, the IRA included a production tax credit of 30 billion US dollars for future technologies, including batteries, for a market that is roughly the same size as that of the EU.[147] This exceeds the funds released to date many times over and supports the Draghi Report's diagnosis that public funding for net-zero technologies in Europe is insufficient.

In summer 2024, the European Commission announced the creation of an EU Competitiveness Fund. This is intended to finance future technologies and will be part of the next EU budget.[148] In order for the Competitiveness Fund to have an impact, it must also be sufficiently large. However, given the tight budgetary situation in many Member States on the one hand and increased military spending on the other, Member States are likely to be sceptical about increasing the next EU budget. Given the strategic importance of the battery value chain, the member states and the Commission should work together to ensure that more money is made available in future for a European battery value chain, strategic partnerships and the Global Gateway. This makes

145 Strategic Perspectives (2024).
146 European Commission (2025a).
147 IEA (2023).
148 Reuters (2024b).

it all the more important that the European framework for industrial promotion also enables the mobilization of private capital.

No less crucial is the issue of common rules for foreign direct investment. Currently, there is competition between member states for foreign direct investment (see insight 4.3). For this reason, all policy instruments contained in this programme should be embedded in a broader strategy. The European Union needs a strategy for the industrial establishment of Chinese companies based on common rules to promote fair competition. This would require that the European Commission plays a coordinating role and that European minimum standards are uniformly implemented in environmental protection and workers' rights. This strategy should aim to expand the range of products and services available to consumers, secure endangered production sites, localise value chains and promote competitiveness through joint ventures in technology development. Such a proactive industrial policy would have the potential to reduce the enormous dependence on the Chinese market in the long term (derisking).[149]

Similarly, the resilience of European supply chains should always be considered from an international perspective. This means accounting for the involvement of international partner countries, including those in Africa and Latin America, in international material flows. This applies to joint ventures between European partners in these countries with the aim of enabling technology transfer in the battery value chain, but also to closing material cycles (for example, black mass) and establishing a "recycling supply chain". It is important to consider how the current debate on free trade versus protectionism considers the perspectives of the industrialising nations of the South. From their point of view, market access to industrialised and emerging economies is desirable, and the promoting activity in higher value-added segments of the value chain is an important part of economic policy. From this angle, the CBAM is seen as a protectionist measure that disadvantages developing and emerging countries. When restructuring economic interdependencies, countries rich in raw materials must be considered to a much greater degree and in different ways than has been the case to date. In a seller's market, they will be empowered to define the conditions for cooperation much more than has been the case to date.

In conclusion, Europe is in danger of falling behind in the global race for clean technology. Once the dominance of battery production sites and their associated ecosystem is established outside Europe, the European Union faces a significant loss of competitiveness. The issue should therefore be a priority for the new German government, which should support the above-mentioned elements in its Automotive Action Plan. There is no question that a European response to the global race for the technology of the future is needed. This response should encourage Chinese companies to produce in Europe and enable European players to learn from their technological lead through joint ventures.

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List of abbreviations

ASSB	All-Solid-State Battery
BMBF	Federal Ministry of Education and Research
CBAM	Carbon Border Adjustment Mechanism
CRMA	Critical Raw Materials Act
IPCEI	Important Project of Common European Interest
IRA	Inflation Reduction Act
KTF	Climate and Transformation Fund (in Germany)
LFP	Lithium iron phosphate
LMFP	Lithium manganese iron phosphate
NMC	Lithium nickel manganese cobalt oxide
NZE	Net-zero emissions scenario of the IEA
NZIA	Net-Zero Industry Act
NCA	Lithium-nickel-cobalt-aluminium oxide
SIB	Sodium-ion battery
STEPS	Stated Policies Scenario of the IEA

132-2025-EN

Agora Verkehrswende is a think tank for climate-neutral mobility headquartered in Berlin. A non-partisan charitable organisation, Agora advocates for a complete elimination of greenhouse gas emissions in the transport sector, in dialogue with stakeholders from politics, business, research and civil society. The team develops scientifically substantiated analyses, strategies and proposals for solutions.

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